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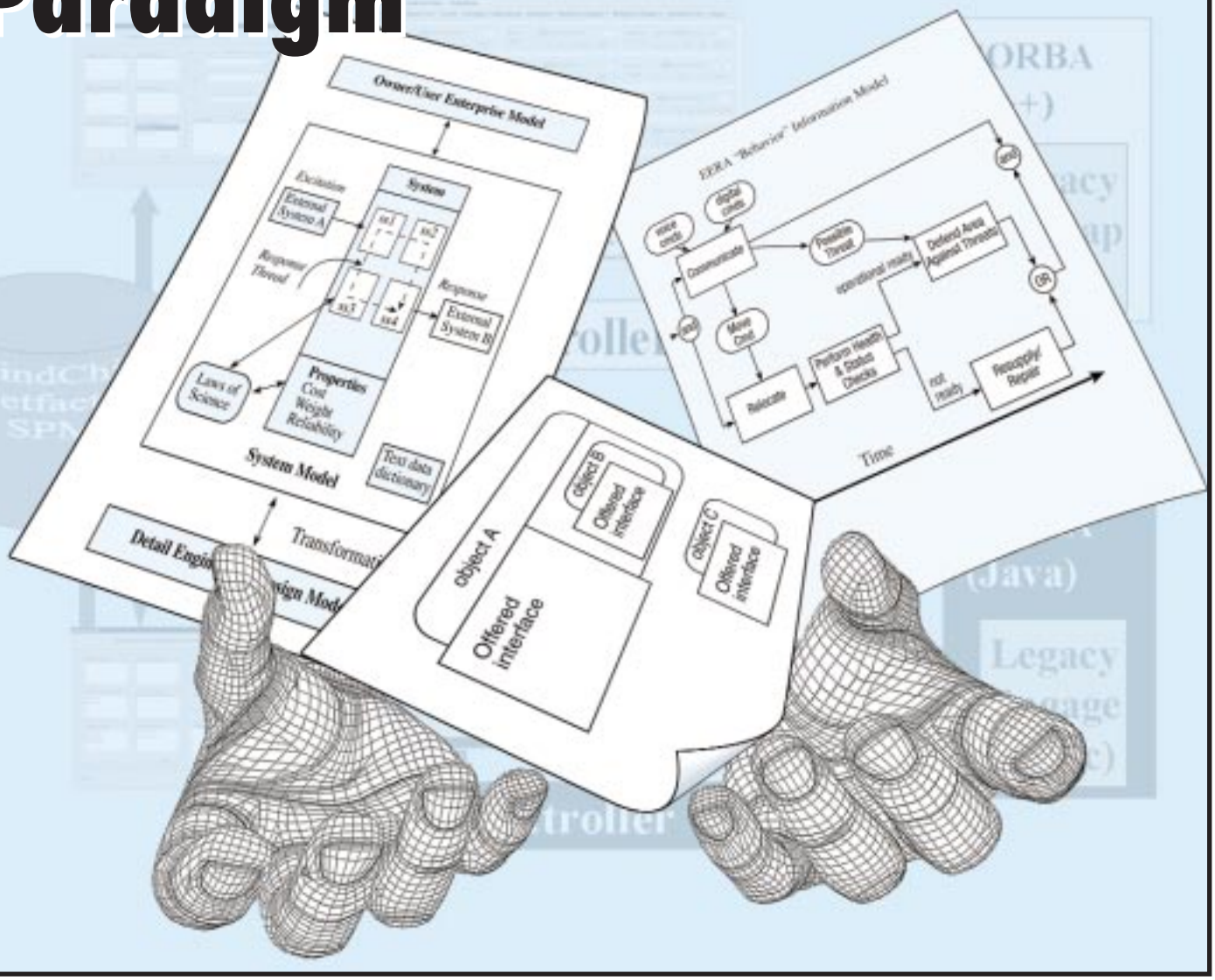
Model-Based Systems Engineering: A New Paradigm



INCOSE
INSIGHT
A PUBLICATION OF THE INTERNATIONAL COUNCIL OF SYSTEMS ENGINEERING

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Copy Editors: Donna Rhodes, Lori Pajerek, Shirley Bishop

Who are we? INCOSE is a 3000+ member organization of systems engineers and others interested in systems engineering. Its purpose is to foster the definition, understanding, and practice of world class systems engineering in industry, government, and academia. INCOSE is comprised of chapters located in cities worldwide and is sponsored by a corporate advisory board and led by elected officers, Regional Directors, and Directors-at-Large.

From the Editor

Model-Based Systems Engineering: A New Paradigm

OUR HERITAGE. In many organizations, systems engineers have been known as prolific producers of proscriptive prose; the "paper pushers" of the design team. The hardware and software engineers have something more tangible to point at as the fruits of their labor. On the other hand, most of the systems engineer's work seems more cerebral—analyzing requirements, conceiving behavioral models, allocating behavior to physical design and test planning. The physical manifestations of SE efforts are documents, such as specifications, trade studies, and test plans. These documents have been the primary means of communicating requirements to hardware and software designers.

Ambiguous and incorrect requirements have long been recognized as primary causes of design errors. Many organizations attacked these errors by requiring formal inspections of specifications prior to approval. Inspections have been shown to be an effective means of catching errors, if the inspection team is rigorous in its process. However, for many it is "just another hoop to jump through" and is considered an impediment to getting the job done on schedule. There are three primary problems with the paper-driven approach:

1. Specifications are often written after the design is complete and merely used to record the results. Unfortunately, the specification is frequently assigned to some junior engineer on the team, who has not gained the skills needed to produce a high-quality specification.
2. Written words tend to be ambiguous. There are multiple meanings for the same word, which can lead to misunderstandings.
3. Requirements generation are perceived as just words. No one has the time to learn other, more meaningful, methods to fully define the requirements.

Within the last decade, and primarily as a result of the expanded capabilities of personal computers (PC), it has become possible to design a system completely using a computer-aided systems engineering (CASE) tool. Prior to this, it was necessary to implement such tools on a mainframe or a high-end UNIX system. But now, any reasonable PC is sufficient. Consequently, the capital investment to the user is low, and the return, in improved quality and productivity, is high.

THE NEW PARADIGM. Let's discuss how you might use this new computing power to their benefit. While analyzing the requirements for a project, an engineer frequently identifies "problem" requirements. They could be the inevitable "to be determined," omissions, or requirements that just don't make sense. In any case, these need to be identified as issues, resolved, and tracked to conclusion. The rationale for resolution of the issues can be, and should be, carried in the same database.

When all requirements are understood and all issues resolved, you can develop one or more functional models, for example, that fulfill those requirements. By tracing the requirements to the functions in your model, you will gain assurance that all requirements have been addressed. In addition, there are other benefits, such as being able to identify

any functions that cannot be traced from requirements. These functions may be found to be superfluous. Building the behavior of the system in this manner is only part of the task. Another task may be to simulate model behaviors in order to verify logical correctness. The simulator can also be used to trade off the performance of the models.

Another aspect of modeling is the physical design, which allocates functions to the three primary components of a system: hardware, software and people. The physical allocation can make a big difference in the performance of the eventual system. An engineer should investigate several physical designs and perform trade-off studies against criteria important to the design effort.

The system design still must be validated and verified. All requirements must be testable, or they are not requirements. The systems engineer should have a plan to demonstrate compliance of each requirement. During this activity, a model will help in grouping requirements for efficient testing. Finally, the project database can keep track of all testing status and open issues related to that testing. In essence, a systems engineering tool will become your corporate memory for the project.

All of the above activities can be supported by a full life-cycle computer aided systems engineering (CASE) tool. Some of the benefits you will realize with a model-driven approach to systems engineering are:

1. All requirements, and the rationale behind them, will be accessible to the designers.
2. The completeness of your design can be assessed by tracing the requirements to functions and their allocation to physical components.
3. All views of the requirements are saying the same thing. There are no disconnects among the representations of the data.
4. The corporate memory of a project can be retained when the staff is reassigned. Some projects may last ten years, and have several systems engineers on the team.
5. A simulator must be part of the CASE tool and, therefore, be instrumental in executing the actual behavior. External simulators cannot guarantee that the behavior and simulator are managed to the same technical solution and constraints. Analyzing behaviors in external simulators often modifies the system concept.

Intuitively, we know that system design using a model-driven paradigm is going to save money and improve quality, just as we knew that improved software capability maturity will improve product quality. Unfortunately, no one has the time and the resources to run two concurrent development efforts to validate this belief. With the Software Engineering Institute (SEI) Capability Maturity Model (CMM), several companies tracked their continued improvement as they increased in software maturity. They were able to show almost an order of magnitude improvement in quality and productivity and up to a five-fold improvement in cycle time. We should do the same for systems engineering process. Anytime a change in process is made, metrics are essential to verify that the change did improve the process.

The theme of this issue of ***INSIGHT*** is "model-based systems engineering." We are fortunate to have some excellent articles on various aspects of the model-based paradigm. The first article in the series is from the Model Based System Development Working Group, authored by Howard Lykins and Bob Cohen. Byron Purves and Loyd Baker, co-chairs of the Model-Driven System Design Working Group, offer a look at "Information Models as a Prerequisite to Software Tool Interoperability." Ingmar Ogren, from Sweden, offers some different views in his article on the "Aspects of Modeling." Dr. David Oliver, author of "Engineering Complex Systems with Models and Objects," discusses the benefits of model-based engineering. Lastly, the Smart Product Model application to the U.S. Navy DD21 program is described by Jerry Golub, in an article that represents large scale, complex system modeling.

We thank the authors for taking time from their busy schedules to help the INCOSE membership to understand the value of model-based systems engineering.

Regards,
Jerry Fisher
Theme Editor

INCOSE Membership Directory Update

An update of the INCOSE/SESA membership directories will be available October 1, 1998 on the INCOSE web site at http://www.incose.org/members/ for both Windows and Macintosh users. Instructions for downloading the files and uncompressing them will be provided on the web site. INCOSE provides this directory to current members to further the goals of INCOSE.

Please keep your listing up to date when you move, change jobs, or get a new telephone number or e-mail address. Send corrections to the INCOSE Office at incose@halcyon.com, 800-366-1164 (toll-free U.S.), or (206) 361-6607. The Membership Committee issues this directory on a regular basis. Comments about the format, or what other information should be included, are welcomed.

Remember that this is a membership database, and not a mailing list. Please do not abuse this privilege

The INCOSE Model Driven System Design Interest Group

Howard Lykins, lykins@software.org and Bob Cohen, cohenrm@utrc.utc.com

The Model Driven System Design (MDSD) Interest Group is part of the INCOSE Modeling and Tools Technical Committee. The purpose of the committee is to "advance the state of the practice of systems engineering through the use of COTS tools and models." The role of the MDSD group within the committee is to "characterize model driven system design and identify migration strategies from present document driven approaches." Two other groups within the committee, the Tools Database and the Tools Integration and Interoperability Working Groups, work with the state of the practice. On the other hand, MDSD is more visionary in nature. Our purpose is to extend the state of the art in systems modeling and realization, and to provide input to the other groups. The Modeling and Tools Technical Committee also includes the Information Model and Process Working Group. Information about these four working groups and those in other technical committees is available from the INCOSE web site (http://www.incose.org).

A 1996 white paper written by the MDSD Group defines a model as "a limited representation of a system or process" [Baker et al. 1996]. MDSD is particularly interested in *machine interrogable models,* which are recorded and maintained by software tools. These tools assist the systems engineer by ensuring that models are consistent and complete, and by answering questions posed by the engineer. Modeling tools can also assist in bridging the gaps between engineering disciplines and between technical and non-technical stakeholders in the development process. In the future, automated tools should be able to help integrate disciplines by maintaining "meta-data" that describes the information maintained by various models. This meta-data will identify information available in the models of one discipline (such as electrical engineering) needed by engineers in other areas (such as software or mechanical engineering). In addition, model-based tools will abstract, from detailed engineering models, the information that non-technical decision-makers need to support the engineering process. This reduces the risks of overwhelming these stakeholders with technical detail and of introducing error through manual abstraction.

Many issues are open to investigation by the group. Examples discussed at the 1998 symposium include:

- Integration of modeling techniques across multiple disciplines and perspectives

  A systems view may need to consider mechanical, electrical, human (individual, organizational, and societal), software, financial, and other issues. Each of these interest areas has its set of reference disciplines, e.g., structural engineering, aerodynamics, numerical methods, discrete or continuous simulation, cognitive science, ergonomics, economic models.

- Evaluation of new and innovative modeling techniques, and use of existing techniques for new purposes

  For example, techniques successfully used to evaluate alternative hardware architectures should be useful for systems in which software predominates.

- Devising ways for organizations new to model driven system design to profit from lessons learned by more experienced organizations, such as the Jet Propulsion Laboratory (JPL)

  JPL demonstrated part of their modeling environment at the 1997 symposium and again in 1998. This year, they provided a "virtual" technical tour in Vancouver of their facility in Palo Alto, California. The JPL environment combines multi-level and multi-disciplinary teamwork, modeling and database tools, training, business concepts, and information technology to engage its people in focused product realization. Although far from complete, JPL's progress demonstrates the ability of an organization to reinvent itself through investment of effort, creativity, and trust.

- Exploring ways in which the systems engineering process should change as the use of computer-interrogable models replaces textual documents

- Categorization of system behavior in terms of:

  1) Behavior type
  2) Approach to model behavior
  3) Techniques for analyzing the type of behavior

- Development of a set of scenarios (e.g., use cases) for using an integrated set of models

- Development of a taxonomy to organize product modeling techniques and to identify the interfaces that would ensure semantically rich exchange of information between models, especially across technical disciplines

• Development of a taxonomy to organize process modeling techniques and to identify where different modeling techniques must be integrated. The basis for the taxonomy could be:

1) *A systems engineering process.* Many candidates come to mind. General-purpose processes include the British Defence Evaluation and Research Agency process [DERA 1997] and the Generic Systems Engineering Process [Cochran et al. 1995]. The Integrated Systems and Software Engineering Process [Rose 1997; Lykins 1997] is targeted specifically toward software intensive systems. The process documented by Oliver, Kelliher, and Keegan [1997] was developed with modeling in mind.
2) *A maturity model such as the SE-CMM or the SECM.* We could use a general-purpose process as the organizational framework, possibly together with a maturity model. A maturity model is essentially a set of requirements for a systems engineering process; it could also serve as a source of requirements for modeling and model integration.

The issues we investigate and the work we do will be determined by the overall mission of the group and the interests of its members. By the end of the 1998 symposium, the MDSD Interest Group had over twenty members from England, France, Germany, Sweden, and the United States. In addition, the MDSD group has a strong working relationship with the Information Model and Process group, and with similar groups within the IEEE Technical Committee on Engineering Computer Based Systems. MDSD accomplishments and activities to date include:

• An article published in the INCOSE 1996 Symposium Proceedings [Baker et al. 1996], and republished (abridged) in ***INSIGHT*** in 1998 [Baker et al. 1998]

• A working meeting in the Fall of 1996

• Annual meetings at the symposia and the international workshops

Over the next year, the group hopes to:
• Hold a forum at the 1999 symposium dealing with model driven systems engineering. The content of the forum is yet to be determined, and could include:
1) A panel discussion of experts in modeling and model driven systems engineering
2) Presentation of a "straw-man" approach for model driven systems engineering
3) Discussion among all participants of open issues, leading to a recommended agenda for research and development

• Maintain discussions via the Internet and meetings on the above topics, with specific focus on the proposed 1999 forum. Two meetings are anticipated:

1) Late 1998 to clarify goals and parameters for the 1999 forum. Possible locations include Connecticut, Northern Virginia, or Monterey, California.
2) January 1999 at the International Workshop to finalize content and format for the 1999 forum.

The group is looking forward to a successful and productive year. Membership is open to anyone who is interested in model based systems engineering and has time to devote to group activities. Interested parties should contact one of the co-chairs of the group:

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Seven INCOSE Fellows Named

Elliot Axelband, axelband@atlas.usc.edu

Seven INCOSE Fellows were announced at the 8th Annual International Symposium in Vancouver, Canada on July 31. INCOSE Fellows are selected on the basis of their significant contributions to the profession and practice of systems engineering. They are highly respected internationally as authors, researchers, and practitioners of systems engineering. The seven new Fellows are:

Terry Bahill - Professor of Systems and Industrial Engineering, University of Arizona, President of Bahill Intelligent Computer Systems, and Editor of the CRC Press Series on Systems Engineering.

Benjamin Blanchard - Chairman of the Systems Engineering Program at Virginia Polytechnic Institute, and author of numerous textbooks including classics on systems engineering.

George Friedman - Retired Vice President of Engineering and Technology at the Northrop Corporation, and Adjunct Professor of Systems Engineering at the University of Southern California.

James N. Martin - Lead Systems Engineer and Program Manager at Raytheon Systems Company, and author of numerous technical papers and a text on systems engineering process, methods and tools.

Andrew Sage - Founding Dean Emeritus, School of Information Technology and Engineering, George Mason University, author of numerous textbooks and papers on systems engineering, and editor of both the INCOSE Journal of Systems Engineering and the IEEE Transactions on Systems, Man and Cybernetics.

Richard J. Stevens - Chief Technical Officer of Quality Systems and Software, architect and design team leader for the DOORS requirements management tool, and former Director of Systems Engineering for the UK Defence Evaluation and Research Agency.

Wayne Wymore - Principal Systems Engineer and sole proprietor of SANDS (Systems Engineering and Design Systems), former Professor of Systems Engineering at the University of Arizona, and author of numerous texts and papers on systems engineering.

Information Models as a Prerequisite to Software Tool Interoperability

Byron Purves, byron.purves@boeing.com and Loyd Baker, Lbaker@vtcorp.com

Have you ever asked, "Why is it so painful to transfer information between the tools used on my project?" If you have, then you can relate to the following scenario.

Phase 1: You have invested considerable time and energy in learning to use a new computer-based tool for functional analysis. With this tool you have constructed a credible functional model of a system that satisfies your customers needs (i.e., high-level functional requirements). The project now decides to use a different tool for its requirements management. Some of the data you developed needs to be transferred to the new tool. The requirements people assure you that this is a one-time event to initialize their process.

Response 1: You investigate the information structures and vehicles for extracting and importing data for both tools, and discover that the designers of these tools thought about their data in quite different ways. The functional analysis tool uses functional-flow diagrams and entity-relationship-attribute structures to capture supporting textual information and data parameters, while the requirements management tool uses text-fragments and data parameters linked together using relational tables. The transfer of the textual information and data parameters is straight forward and only takes a few days once the mapping between information structures is defined. However, transfer of the functional flow information presents a problem, since the requirements management tool does not support a graphical representation of time-sequence of conditional events. The only option is to manually generate text fragments that describe the conditional sequencing contained in the functional-flow model. At this point, you voice a concern that this transfer is a waste of time because this activity is going from a more detailed specification of the proposed solution back to a less detailed specification. The decision is made to manually convert the functional model's conditional sequencing information into textual descriptions.

Phase 2: Your customer expands the scope of your project. New functions are required. You comply with the contract change and revise your functional analysis model. Now the requirements people want to transfer the updates (changes, revisions and deletions) to their requirements tool.

Response 2: Things get a bit tense. You remind them that the transfer was supposed to be a one-time database initialization. But they say it has to be done. The cost and risk of manual data reentry is too high. You warn of the difficulties, but your boss insists you update the bridge. You look more deeply into the data structures of your tools and decide that it can be done. You build a new bridge and do a lot of testing on database copies (especially the delete). After three anxious weeks you have the bridge running for this dataset.

Phase 3: After a few months, your boss tells you that the requirements people have done some really neat work in populating their database. They showed it to the customer who thought that some of their data ought to be included in an update of the functional analysis report, and your boss had agreed to do it. "After all," he said, "you already have a bridge running." You explain to your boss that "maintaining the bridge" takes resources away from your functional analysis and verification task (i.e., your real job).

Response 3: Things get really tense. Data transfer between different structures is not always straight forward. You had been able to transfer the data because the requirements tool only needed a projection of your functional analysis data — rather like the shadow of a three-dimensional object on a plane wall. Now, given the shadow they want you to construct, or at least update the three dimensional shape which created it. This is tricky. You have to make some assumptions. You discuss these with the requirements crew and agree on a set of assumptions. Now you build the inverse bridge. It takes a month. And you worry a little about the quality of the results. You generate a large report for people to review, but nobody reports any errors. You wonder if anyone, other than yourself, did a complete review. At this point, you accept a job on another project.

Of course, this is fiction. But there is at least a hint of reality. This little scenario exposes the following lessons learned:

1. When selecting your project's computer-based systems engineering tools, don't depend on ***ad hoc interfaces*** between the tools. You want your project personnel focused on the system to be specified, not building custom bridges between tools.
2. The ***system information models***, supported by the systems engineering tools, must support the modeling of system operational behavior as well as the traditional text-fragment and data parameter traceability structures. In the Spring '98 ***INSIGHT***, the INCOSE Model Driven System Design (MDSD) Working Group discussed reasons why program managers are adopting a model-based approach to systems and

business process engineering. The key reasons presented were:

a) Improved communication of ideas and concepts between project personnel when using information models over the traditional document-based approaches. As we all know, a "picture" or "graphic" provides greater visibility and quicker understanding over textual descriptions.

b) Improved analysis and verification capabilities through automated interrogation of the system information models.

c) Ability to automatically generate, and re-generate, documentation based on the semantic rules embedded in the various kinds of system/process information models.

The remainder of this article contains an overview of a System Information Modeling Language that supports systems engineering tool interoperability.

System Information Models That Support Tool Interoperability. Entity-Relationship-Attribute (ERA) information models have been successfully utilized by several systems engineering tools. In a conventional ERA language (see Figure 1), the building blocks are defined as follows:

• **Entities** (i.e., objects) identify the *things* of importance in an organization, system, or process. Entities are the objects that serve as the basic units of knowledge in the systems engineering process. An entity corresponds to a *noun* in English. Entities have attributes and entities may have relationships to other entities.

• **Relationships** define associations between the system/process entities. Relationships are similar to *verbs* in English.

• **Attributes** define the properties/characteristics of an entity much like *adjectives* modify nouns. For instance, attributes of a requirement entity might include the requirement name, textual requirement statement, rationale, and status.

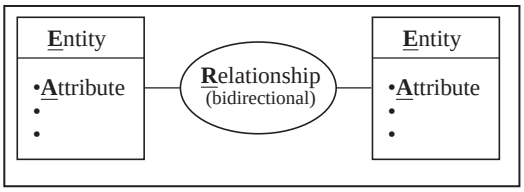

Figure 1 - Conventional ERA Modeling Language

Based on our experiences using ERA information models on numerous applications in the defense, aerospace, commercial, and energy environments, we recommend that the conventional ERA language be extended. We believe you should allow attributes to be associated with the relationships between entities so that an explicit specification of the interface(s) between entities can be captured. The template for this Extended ERA (EERA) Information Modeling Language is presented in Figure 2.

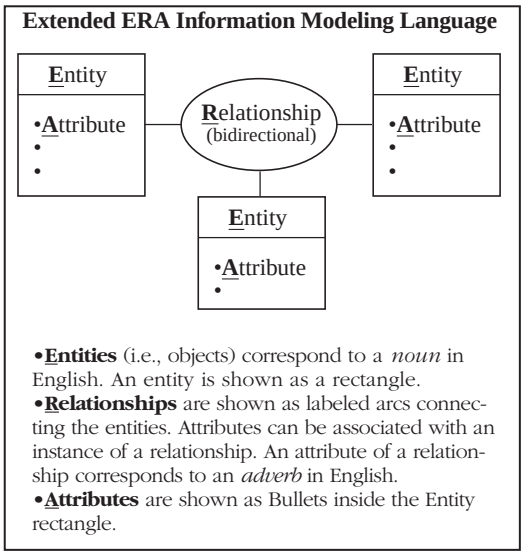

Figure 2 - Extended Entity-Relationship-Attribute Language

The definition of a standard set of systems engineering entities, relationships, and attributes will be published by INCOSE Model Driven System Design (MDSD) Working Group.

To completely specify a system, there are four basic information models that must be developed. They are:

- Requirements Traceability Model
- System Interface Model
- System Behavioral Model
- System Architecture Model.

Therefore, to ensure adequate tool interoperability, the system information modeling language must support at least these four basic information models. An EERA language example of these models is presented in Figures 3 through 6 *(following page)*.

In Figure 3, the flow down of the initial requirements from source documents, with all issues and risks captured and linked to the appropriate entities using the relationships, is shown. This traceability model provides the basis for common understanding of the interaction of entities, automated analysis, and automated document generation.

In Figure 4 the system external interfaces are identified and modeled. The EERA model specifies the context in which the system must operate while satisfying the requirements identified in the requirements traceability model. This model is also used to specify internal interfaces.

Once the requirements and system interfaces are identified, the project team uses this knowledge base to identify and analyze candidate system behavior models (Figure 5) and alternative system architectures of component-parts (Figure 6). An Enhanced Functional-Flow Block Diagram (EFFBD) technique is used to construct a stimulus-response behavior model (i.e., conditional sequences of required operations) for the system. The behavior model provides an excellent communications mechanism to help the development team, and customers, better understand what the system needs to do and how well it should be done. It also provides for direct evaluation/verification of the proposed problem solutions because the models are executable. Once the system's behavior model is verified, it is partitioned and allocated to the system's component parts (i.e., subsystems) shown in Figure 6.

Additional graphical/textual EERA

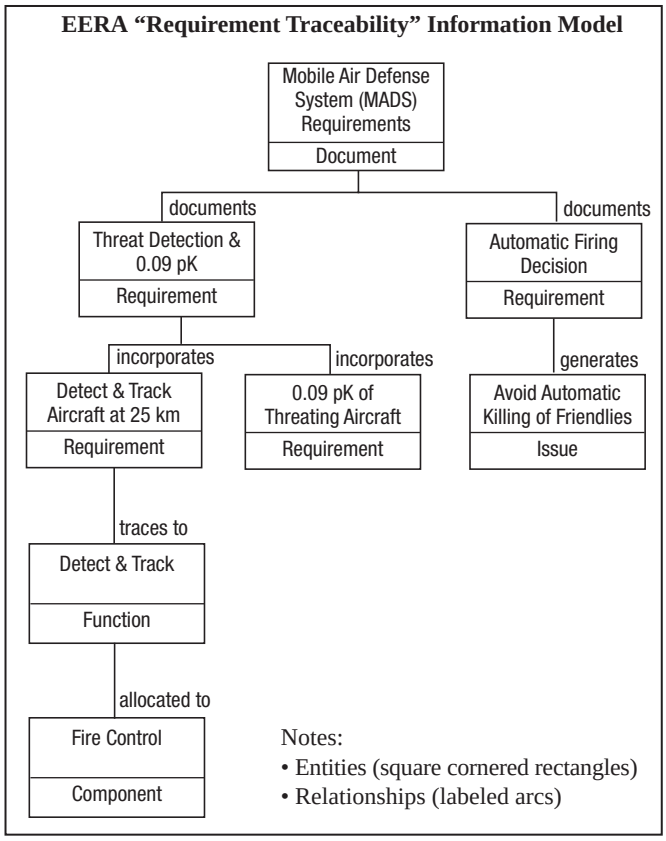

Figure 3 - Sample Requirements Traceability Information Model

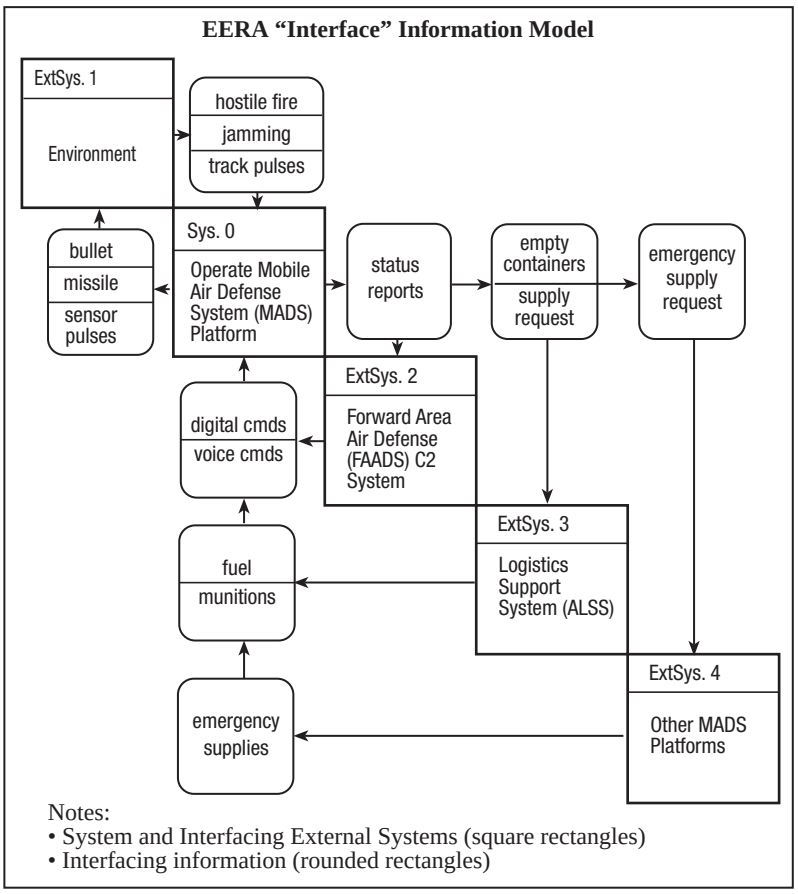

Figure 4 - Sample System Interface Information Model

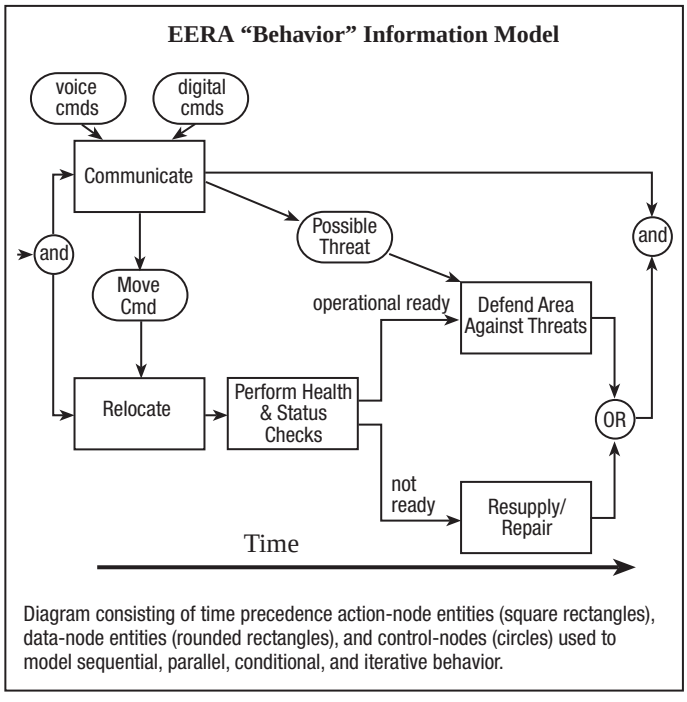

Figure 5 - Sample System Behavior Information Model

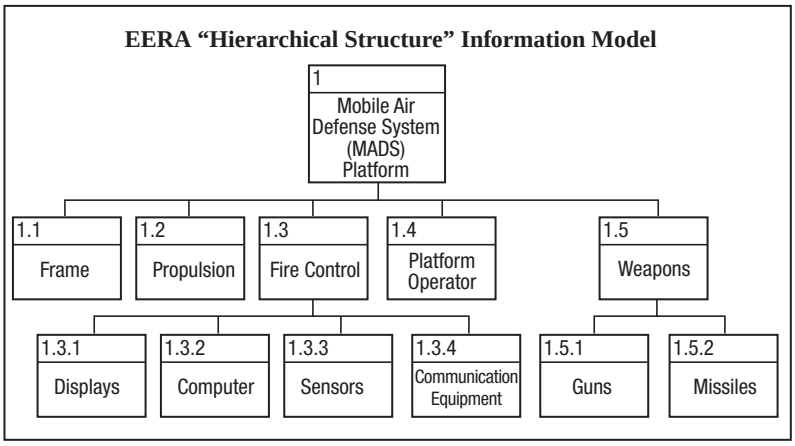

Figure 6 - Sample System Architecture Information Model

language models can be added to support project specific system processes.

Conclusion. A standard *System Information Modeling Language* that supports systems engineering tool interoperability is needed. This information modeling language must support, at a minimum, the four basic information models needed to completely specify a system.

- Requirements Traceability Model
- System Interface Model
- System Behavioral Model
- System Architecture Model.

Aspects of Modeling

Ingmar Ogren, og@toolforsystems.com

How do you know what you model? When you review a software or systems engineering diagram, you often come across simple entities such as "air temperature" or "aircraft position." You can ask the diagram author what this means: Is it really the aircraft position or is it the computer's understanding of the position? The question may cause some confusion and most often the answer will be something like, "It is this entry in the data dictionary, represented by that floating point data." If you then put the next question, "How do you know it is the real position?", you may get a clear, crisp and understandable answer. You may also get a confusing discussion of data, communication paths and delays throughout the system, which leaves you with little understanding of how well the data represents its counterpart in the real world.

In these cases it may help to draw a UOD diagram (UOD= Universe Of Discourse). This is a simple way to increase knowledge of how entities in a system represent and connect to entities in the "real world." To draw a UOD diagram, start with an entity in the real world, such as an aircraft:

Figure 1 - UOD Diagram

Next, you can introduce a radar to detect the aircraft. Further, a couple of relations exist between the radar and the aircraft. The relations are drawn in both directions to show that this is not a Data Flow Diagram, but an Entity-Relationship, which defines entities and relations.

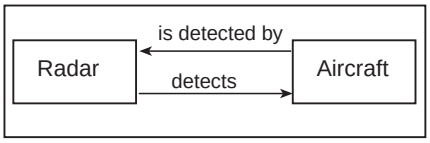

Figure 2 - Entity Relationship

To read and understand the diagram, you simply read: <box text><arrow text><box text>.

When you review a UOD diagram, it is a good idea to read these simple texts to check that they are both readable and say something meaningful about the system. If you then want to build an air traffic control system, the radar and the real aircraft are outside the system, but you need to represent the aircraft in the system:

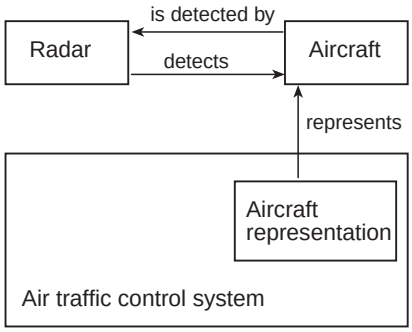

Figure 3 - Represent Aircraft

What you have done so far is establish that radar is used to detect aircraft, and that aircraft must be represented in air traffic control systems. This may seem completely trivial, but establishment of basic facts like these may of crucial importance in other and more complex circumstances.

However, the diagram says nothing about how to build the "Aircraft representation." To complete the diagram, you can introduce an additional entity, the "Tracker," as in Figure 4, with its relations.

You now have a simple UOD diagram with "double coupling." The diagram shows an entity in the environment or "real world" (aircraft) and its representation in a system (aircraft representation). The double coupling means that the diagram shows:

- How the environmental entity is represented in the system
- How the environmental entity influences its representation.

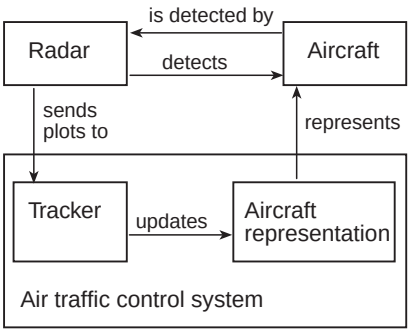

Figure 4 - Add Tracker

The diagram also expresses a number of simple facts about the system in its environment if you read <box text> <arrow text> <box text>. If these sentences don't make sense or are not grammatically correct, the diagram probably needs some further work. What you have done now is, basically, model on two levels:

- The diagram is a model of a system in its environment;
- The diagram shows one aspect of how a system's environment is modeled within the system.

Note that "environment" is not necessarily the real physical environment. For example an embedded computer system may well have other computer systems as its environment.

UOD diagrams can be drawn simply with paper and pencil, and this is often an excellent idea, particularly early in system analysis, when you want to build an understanding of an existing or future system. Drawing these diagrams together with an experienced end-user on a blackboard is a very good way to understand and document basic facts. However remember:

- What you are drawing are entities and their relations, not data flow diagrams;
- Don't make it too complex. Multiple small simple diagrams are better than a big complex diagram, as you will have difficulties seeing the errors in a complex structure.

Tool support is an issue for the UOD-graphs. The blackboard is a wonderful tool, but it has its limitations as a means for persistent information storage. Computer storage is

better and many simple drawing programs, such as PowerPoint or Visio can be used to draw and store UOD diagrams. You can also use other programs with drawing capacity, such CAD or CASE programs.

However, before you select a program to document and store your models, check that it does not have any awkward syntactical limitations, and that it can do useful tricks such "rubberbanding" and "snapping."

How do you model? There are many ways to model a system and you may wonder which one to choose. The answer is very simple: It depends. It depends on which aspect of your system you want to model and who will read your model. Another answer is that you need to master a palette of modeling techniques to cover the needs during a systems engineering effort. You should also consider what is required for modeling a system. Among others, three requirements are:

1. **Determinism with formality.** This means that everything expressed in the model must have a single, defined and obvious meaning.
2. **Understandability.** Since systems engineering should be done in close cooperation with end users, the models used must be readily understood, without extensive education or experience in software or mathematics.
3. **Inclusion of system missions**. This means that the model should elicit the system missions and be able to express how different parts of the system contribute to completion of the missions.

Below some useful techniques for modeling are discussed:

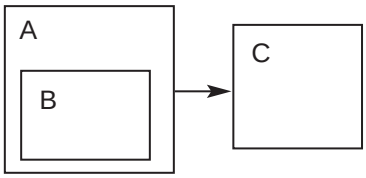

Figure 5 - Block Diagram

The block diagram may be the oldest way to model systems. It is very simple to understand. The above example clearly shows that A contains B, and that B transfers something to C. The block diagram is extensively used for hardware schemata, for organization diagrams, and for software structuring (as data flow and context diagrams). The block diagram is very strong in modeling a system's structure in an understandable way. However, it illustrates very little of the system's missions.

You may wonder if there isn't any useful standard for modeling diagrams. In fact the "three amigos" (Grady Booch, Ivar Jacobson and James Rumbaugh) at Rational Software have created the Unified Modeling Language (UML), which is being standardized. The UML contains a multitude of modeling diagrams, including the class diagram and the component diagram.

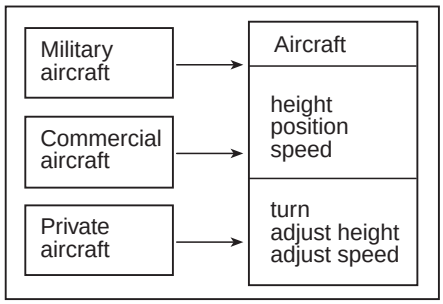

Figure 6 - Class Diagram

Figure 6 shows an aircraft example, drawn in a small subset of the UML class diagram syntax. It shows that the class "Aircraft" has attributes (height, position and speed) and actions (turn, adjust height and adjust speed). It further shows that the three classes "Military aircraft," "Commercial aircraft," and "Private aircraft" are all derived from (inheriting) the class "Aircraft."

This is just a small subset of what you can model with UML class diagrams. You can also model dependency, association, aggregation and cardinality. (For details of the rich syntax, check Rational's web page or the UML literature.) The rich syntax and the great power of expression are obvious advantages for the UML class diagram. The rich syntax may also be a disadvantage as it easy to draw complex and confusing diagrams when you use the full syntax. A good idea, particularly when you work with end-users, is to limit each diagram to a subset of the class diagram syntax.

Another problem is that although the class diagram can be used to show a system's structure in great detail, it does not say very much about the system's missions. Here, UML offers the separate "use case" diagram. A use case diagram will help to understand missions, but may give some problems when you need to do dependability analysis with operator roles integrated as components in the system.

Another UML diagram is the component diagram, described by Grady Booch in the early 1980s. This diagram is quite useful, as it can be used to model compositive object structures. When you work with compositive object structures, you concentrate on each object's interfaces and on connections between objects, rather than on inheritance between objects. The diagram below shows that:

- The object A has an offered interface (constituted from a set of actions, which can be invoked from outside the object);
- The object A has a required interface, constituted from parts of the offered interfaces of the support objects B and C;
- The object B is contained in the same system as object A, while the object C is outside that system.

The component diagram, Figure 7, allows you to model not only hard-

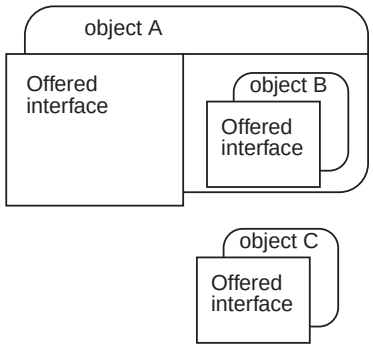

Figure 7 - Component Diagram

ware and software components as objects, but also operator roles and missions. This makes it possible to model complex systems as a set of diagrams on different levels, with clear dependencies among the objects and a clear understanding of how the different objects contribute to completion of the missions. A disadvantage with the component diagram is that it requires some explanation when you work with end-users, who are not familiar with "compositive object orientation."

A common project model. When you work in complex system, be it a transport or energy system, it is quite normal that a multitude of problems surface during problem analysis and design. Many of these problems require simulation, resulting in a situation where you have:

- A "real system" in one or more versions, more or less completed;
- A number of simulators, each modeling an aspect of the real system.

In this situation a horrible suspicion may rise in the developing organization: "Do all these simulators comply with each other and with the real system?"

Another problem when you work in a complex system development is that your end-user will often put your product into a still more complex system. If you produce aircraft, the different airlines will use your aircraft as components in their transport systems If you produce nuclear power plants, the power companies will use your products as components in power distribution systems.

As the end-users will need to analyze and model their systems, they will need a model of your system, to use as a component in their modeling. It would obviously help if you and your end-user used the same model, based on a common understanding. These thoughts have led to the concept of "Common Project Model" (CPM). A CPM is common in two ways:

- It is common for the different implementations of a system, which may be simulations or versions of a "real implementation."
- It is common, and jointly owned, between one or more end-users and contractors with a stake in the system modeled.

How should you, then, build a CPM? Again, the answer is that it depends. There are several modeling tools, and most of them would be useful to build a CPM. Some requirements for a tool to build a CPM are:

- It must be computer-stored. Even if it might be possible to build and maintain a paper-based model, most of us who remember yesterday's documentation binders, with their ink changes and exchange sheets, doubt that such a technique would be useful to document an evolving complex system.
- It must support a compositive (hierarchical) principle to make it obvious who is responsible for which part of the modeled system.
- It must contain not only models of the design objects, but also important attributes of those entities, such as requirements and test cases.
- It must connect, in an efficient way, to different types of models and documents used by contractors and end-users who are concerned by the system modeled. (You must not let the CPM replace the existing documentation, but connect to it.)

How do you then build and use a CPM? The figure above shows that a CPM should be planned from the onset of a system project, although it is also possible to establish the model at a later stage.

Ideally, you start modeling at the concept stage for a new system, to lets the model grow together with the system. The completed model should encompass, not only the system modeled, but also its environment in order to get a good understanding of regular operation of the system modeled.

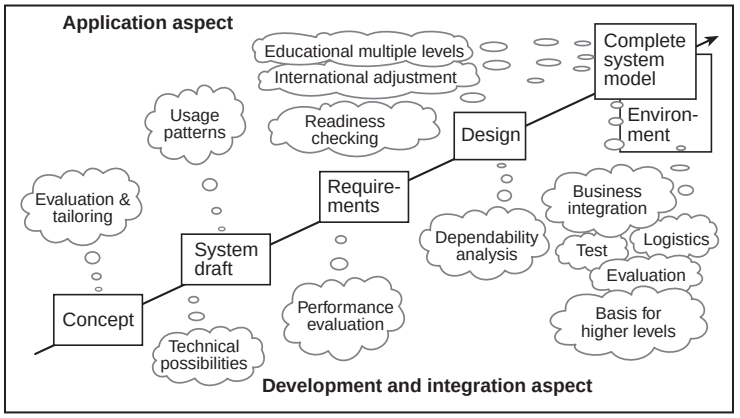

Figure 8 - Planning a Common Project Model

The figure above also shows how the CPM is used from an application point of view, and from a development and integration point of view. Perhaps the most important advantage of a CPM is that it forces cooperating contractors and end-users to face any interface problems, before they are built rigidly into the system. Another important aspect is that it will function as a "corporate memory" for the owning organizations provided the model is maintained.

Above, some aspects of modeling were discussed. What has not been said is that modeling is ***fun***, even if it is often exhausting. It is a very satisfying feeling when you have spent a whole day with a user around a blackboard model, and then got it all into the computer with a conviction that everyone understands and agrees!

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The Benefits of Model Based Engineering

David W. Oliver, dwoliver@ix.netcom.com

INTRODUCTION. Organizations will introduce Model Based Systems Engineering, MBSE [1,2] only when they sell products or services which require a system approach. The management will make decisions to utilize MBSE only if they perceive that the costs and risks of training and implementation will pay off enough to impact the performance of their organization. MBSE must do the system job better, reduce risk, save money in product or service development, and better match product to marketplace. This can happen because the MBSE process works better and is much more efficient and cost effective than the present use of vernacular text. This article describes the benefits of MBSE and estimates the magnitude of improvement possible by reducing the work of creating requirements, tracing them, creating designs, calculating system performance of designs, transforming information for design engineering and management, evaluating requirements changes, and generating test and validation scenarios.

Models of any Subject System and Text Requirements. A subject system, Figure 1, can be modeled by defining all the external systems with which it interacts, the properties of the subject system, the excitations from the external systems, what occurs at the interfaces, and the responses of the subject system to those excitations. An associated data dictionary explains the models. The requirements in models can be executed to produce time lines or perform Monte Carlo calculations. Documents in any form—graphics, text, or a combination—are generated from the models.

Vernacular text requirements typically map to explicit models in a complex many-to-many relationship. Functional requirements describe, with words, the excitations from external systems, the conditions, the inputs to the system, the system response, and the outputs from the system to an external system. Time performance requirements apply to the response threads. Non-time performance requirements describe the properties or attributes required of the subject system. Interface requirements specify the quantities and timing at the interfaces.

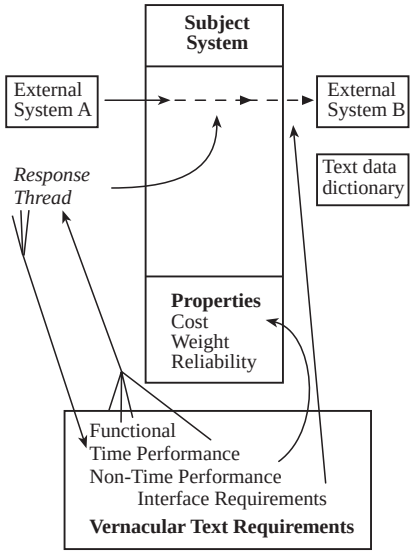

Fig 1 - Map of Models & Text

Simple Map of Requirements to Design with Models. The subject system is assigned as the focus of the engineering group. In the locomotive business, for example, the subject system may be a railway customer enterprise, a locomotive, the locomotive traction system, or the truck which rolls along the rails. Any subject system is specified as shown in Figure 1, and as refined to design as shown in Figure 2.

The response of the system threads through the subsystems and elements of the design. Each of the subsystems or elements is itself described as in Figure 1, with a set of models and a data dictionary. The subsystem properties are budgeted from the properties of the system using the laws

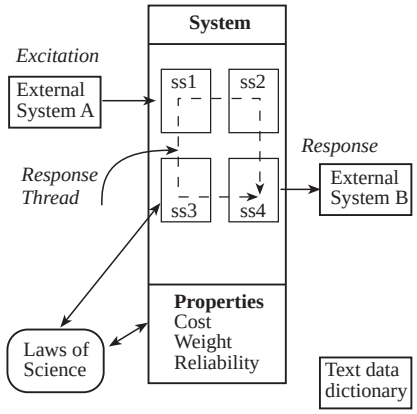

Fig 2 - System Design Model

of science and engineering that apply. When a design has been produced, the properties of the system are calculated using the same laws. Test and validation scenarios consist of measuring the excitation responses defined in the models and the properties specified. All of this modeling work is done with a simple six step core technical process [3].

In contrast to the MBSE approach, requirements in vernacular text typically are written for each level of definition of system, sub-system, etc. Traceability must be maintained among all of the documents, and the mapping from each document to design is typically a many-to-many relationship. The documents, in text, are inherently ambiguous when describing complex systems. The impact assessment of a requirements change or an engineering discovery requires a complex tracing of the change impact through the paragraphs of many documents. Much of this work is eliminated when the system is defined through executable models.

With MBSE, the system, subsystems and components are described in the same consistent way—context, excitation response behavior, and properties, which are all computer executable. The executable requirements in models map directly to the solution and to the performance calculations required for trade-off analyses. This results in a reduction in engineering effort and in requirements management. The requirements are rigorous and can be executed to produce time lines for

responses, to perform Monte Carlo simulations, and for review by users or owners.

Information Transformation. Information is captured only once as shown in Figure 3. Information is transformed and additional information is added as the project continues. This activity needs to efficiently and accurately transform:

- Business strategy and user needs into engineering models;
- Systems requirements to models and performance calculations (and vice versa); both are likely to be complex and application dependent;
- Systems models into the models and notations used by the design disciplines;
- Data into reports and review documents.

Business Strategy and User Needs. This work is concept analysis that models the enterprise using the product and service to establish the benefits to the users/owners. It defines the context of the system as defined in Figure 1 and establishes the top level effectiveness measures which drive the design solutions selected in trade-off. It accounts for the production cost targets that drive producer business strategy and profit margins [3,4].

Engineering Design Models. When requirements are captured in executable models, the information they contain can be transformed to the notations and views used by the design disciplines, like VHDL, C++, and UML diagrams. Currently this information is most often transmitted in vernacular text and requires interpretation by each of the engineering disciplines.

Magnitude of Benefits. Based on actual projects seen in disciplines like CAD/CAM, integrated chip design, and circuit board design, where work from concept analysis through detailed design has been automated, the estimated cost improvement of carrying out model based product development can be as large as 20 to 1. For example, this savings

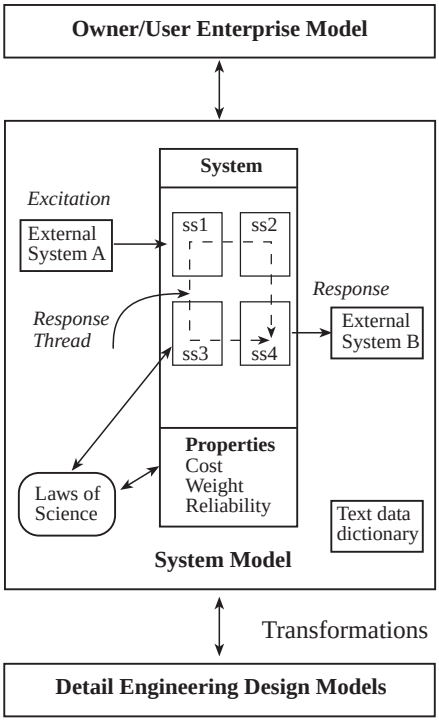

Fig 3 - Information & Transformation

magnitude was observed in a project that captured about ten thousand motor designs. The library of designs had grown so large, it was easier to redesign than to select a special existing design. Model based product development was accomplished by using graphical information models with a simple set of symbols that have meanings that are familiar to users and uniquely defined [5]. Within an hour, the experienced motor engineers learned to put their knowledge into the simple concepts and notation of the models. The SQL code for the information system database was generated error free from the models, and any changes during development could be incorporated by modifying the models, then regenerating code from them.

Problems and Conclusions. Although the best practices and the principles for modeling system requirements and designs have been available and developing since 1975 [1,2], the majority practice has been vernacular text based rather than model based. Several basic problems perpetuate this situation.

- Environments that span the technical tasks are missing, although good point tools exist.
- Interface definitions and automated transformations are lacking between technical systems engineering and the descriptions used for the producer's business strategy and for the enterprise using the product. This is the concept analysis tier.
- Interface definitions and automated transformations are lacking between the models for systems requirements and design, and the application dependent models used to predict system performance, such as cost, response time, reliability, safety, power consumption, and availability.
- Interface definitions and automated transformations are lacking between the models for systems requirements and design, and the tools and notations used by the disciplines that design the components of the system.
- The excellent systems engineering standards that exist are described primarily in vernacular text. They do not provide the process models and the information models needed to establish interfaces, transformations, and semantic equivalencies between the tools in an environment.
- The professionals in the field need concurrence on executable process and information models for the work done in MBSE. These executable models can then guide training, process instantiation in businesses, and creation of a systems engineering environment.

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DD21 Smart Product Model

Jerry Golub, jerome.golub@lmco.com

INTRODUCTION. The U.S. Navy plans to issue the DD21 Detailed Design and Construction contract in 2004, with initial operational capability for the first ship of the class expected in 2009. The DD21 will be a radically new ship. Aggressive cost goals and comprehensive multi-warfare performance requirements present unprecedented challenges to the competing teams. To achieve these ambitious goals, the U.S. Navy has specified that a Smart Product Model (SPM) be used to perform critical cost/performance trade studies before construction begins, and to be a digital representation of the ship throughout the acquisition process. Using a total ship integration approach, the SPM will enable the acquisition of a new class of ship that will achieve production and life cycle cost goals, and meet all mission requirements.

At Lockheed Martin Government Electronic Systems (GES), engineers are employing exciting new technologies to develop a DD21 SPM. This model is a dynamic, web-oriented, distributed, object oriented information database that describes a ship and its behaviors. This model will answer questions from all DD21 domains—mission analysis, design, warfighting and affordability assessment, manufacturing, test and evaluation, training, support, and other phases of the ship life cycle—before any steel is cut or parts purchased.

Since the size of the model could quickly get out of control, the DD21 Project Management Team prioritizes applications of the SPM. They analyze questions from individual Integrated Product Teams to determine which aspects of the SPM will be populated first to provide the highest payoffs. The figure below lists typical questions that will be answered by the DD21 SPM.

To address these questions, information is translated into "use-case" scenarios in order to determine the data, simulations and other tools necessary for the SPM to yield the desired answers. Use case scenarios provide the means of capturing the logic needed to interrogate the SPM and populate it with the resulting behaviors. To "answer" a use-case scenario, the SPM must be able to access simulations and tools normally used to analyze the domain.

The SPM is an element of the DD21 integrated development environment (IDE) which provides the information service (backbone) for the SPM, and allows access to DD21 information across a federated architecture. The DD21 IDE is based on a commercial PDM that manages the entire enterprise including workflow, and includes document management and configuration management.

Based on a ship's work breakdown structure (WBS), the SPM expands the large static data base, with simulations and other engineering tools, to include ship behaviors (see Figure 2 on next page).

Domain	Typical Question
Warfare Assessment	What is the ideal gun/missile ratio considering cost and performance?
Ship Design	What is the best hull form and structure considering cost, performance and manufacturing?
Ship Design	Are mobility and sustained speed meeting requirements?
Crew	What is the minimum crew necessary considering cost and performance?
Cost as an independent variable (CAIV)	Are cost objectives being met?

Figure 1 - Questions asked to prioritize SPM usage

Common Object Resource Broker Architecture (CORBA), a method to integrate a diverse suite of applications, is currently being used to make the simulations and tools accessible by the SPM. CORBA is used as a general-purpose communication medium with IIOP (Interchange Inter-Operability Protocol) as the wire protocol, which allows easy communication between applications in a heterogeneous (mixed platforms, languages) environment. Legacy and COTS tools, including a CAD system and DOORS®, an object oriented requirements management tool, will be wrapped as CORBA objects and become part of the network that is accessible to the Smart Product Model. In addition to CORBA, the SPM will be able to support many current and evolving communication protocols, and currently supports HLA and Java RMI. Since the integrated development environment system on which the SPM is based is written entirely in Java, providing Java front ends allows direct method calls to invoke clients, in addition to the normal benefits of having the application be web-based.

High Level Architecture (HLA), a DoD initiative, provides the basis for establishing interoperability within simulations, among simulations of a federation, and across functional communities. Interface definitions allow exchange of data, and object model and time management constraints facilitate consistent interpretation of data. HLA facilitates reuse of simulation components for both object representations and infrastructure functionality. For the SPM, HLA will be used mainly for communications and synchronization between simulations.

An example. As a preliminary step toward building the DD21 SPM, a systems engineering problem is being piloted on SPM, namely, "What is the optimal height for the DD21 prime radar with respect to cost and AAW performance?" This question will be addressed as a SPM use case scenario. Currently, engineers use

two legacy simulations, SEATRAP, a Radar System performance model, and ENGAGE, a weapon system performance model, to solve this problem. Prior to SPM, the models ran on separate computers, and the the results from SEATRAP had to be manually entered into ENGAGE in order to determine the probability of annihilating a specific air-to-surface raid. Now, using SPM, these models have been wrapped as CORBA objects and may be accessed by the Pilot SPM (Figure 2), and their inputs and outputs can dictate the initial radar, missile, and target data to be included in the SPM. As you can see, a strength of the Smart Product Model is the ability to capture existing processes and make them easier to use. In addition, previous analyses of similar problems have not considered aspects such as cost and manufacturing, which will also be included in our SPM.

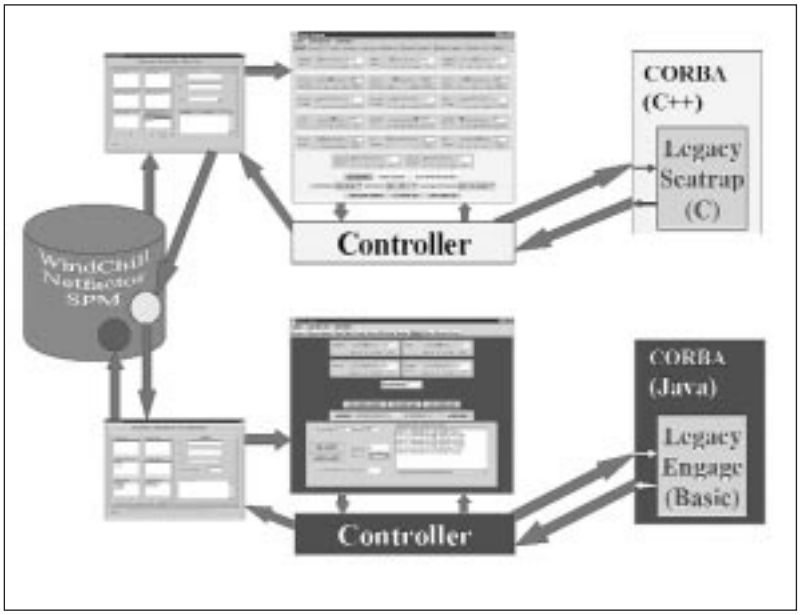


Figure 2 - Process Flow in Radar Height Study Pilot SPM

The range of radar heights to be evaluated is selected by sliding the graphical radar to its minimum and maximum positions (Figure 3).

Continuing this example further, the specific raid is selected from the scenario library, and SEATRAP executes simulations for the range of radar heights and determines the probability of raid annihilation as a function of height. The results are plotted automatically by the SPM. The user need not be aware of the underlying cross-platform simulations that are invoked to answer the engineering problem. For the user, the entire operation is accessed from a single workstation and the SEATRAP output is transferred to ENGAGE via the SPM where the results are stored. (Figure 4 is an example of an output.) The stored results provide a form of configuration management that permits traceability back through the simulations to the original case input parameters.

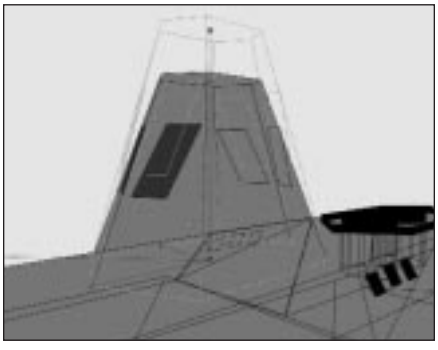


Figure 3 - DD21 showing "slideable" mast at 2 positions

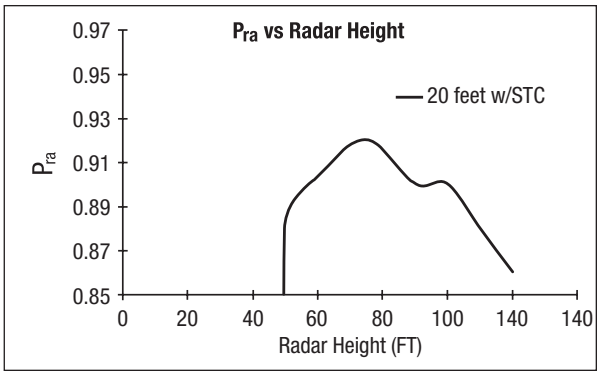


Figure 4 - P(raid annihilation) vs. RADAR height graph

Using unclassified data within the models, we have shown in this figure that based on performance alone, the best radar height to annihilate an 8-target raid is 77 feet. When cost and other factors are added to our SPM, and additional scenarios are analyzed, an optimal radar height based on more comprehensive information will be computed.

Summary. While suing any modeling environment to perform mission effectiveness trade studies is an effective way to determine high level system requirements early in the design phase, the power of the SPM is its contribution in the effort to design a ship that meets both cost and performance requirements. The SPM is the medium that allows true distributed collaborative engineering between contractor and customer.

Currently, the pilot SPM is being expanded to include the behavior of Pleiades, an object oriented, force-on-force simulation. Soon analysts will use Pleiades in the SPM environment to determine the best combination of guns and missiles in a Naval Surface Fire Support (NSFS).

This promising start shows that the SPM is an effective means to reduce DD21 costs and development time from concept development throughout the life cycle, while providing a more robust design. A CAD system and tools for analyzing staffing, logistics, cost as an independent variable (CAIV), manufacturing, and other DD21 acquisition concerns are being added to the smart product model and tool set. SPM is the methodology that will allow the Navy-industry DD21 team to design, manufacture, test and support a total ship in order to meet aggressive cost and performance goals.

President's Corner

Bill Schoening, william.w.schoening@boeing.com

Our extremely successful Eighth Annual International Symposium in Vancouver is one example of the advances that continue to be made by INCOSE. Work products from our technical working groups, the Journal of Systems Engineering, new chapters, new organizations joining the Corporate Advisory Board, and a growing number of liaisons with other professional societies are all marks of our progress.

Two of our primary products—Systems Engineering Standard, EIA 632 and the Systems Engineering Capability Model, EIA/IS 731—have completed another round of balloting and are expected to be forwarded for release by October. Both are joint ventures with the Electronic Industrial Alliance G47 committee, and are full-fledged INCOSE efforts. Members of the author committees are nearly all INCOSE members, and INCOSE has been an equal partner in developing these exceptional documents. If you have not seen the ballot copies, both EIA 632 and EIA/IS 731 are unusually readable when compared to similar standards, and should prove readily usable on the job. I want to stress that INCOSE members from around the world have had the opportunity to review and comment on 632. Hal Wilson, chair of the EIA G47 committee, has stated that it is due to the hard work and timely responses of both INCOSE reviewers and the INCOSE authors that these products are in such excellent shape. INCOSE's James N. Martin chairs the EIA 632 committee, and INCOSE's Karl Arunski chairs the EIA IS 731 committee. You will be reading more about these INCOSE products in the coming months. The status of EIA 632 can be found on page 42.

I am excited about some new additions to the organization's infrastructure:

- Two new chapters have been chartered both in Virginia—Hampton Roads Area and Central Virginia.
- Our newest Corporate Advisory Board (CAB) member is the U.S. Department of Energy - Idaho. This organization brings a new dimension to the CAB with its focus on the disposal phase of product life cycle.

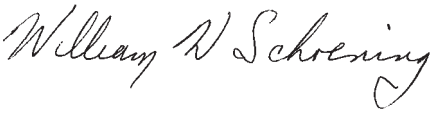
Two issues of the Journal have been published, with two more coming by the end of this calendar year. Andy Sage, Chief Editor of the Journal, is assembling excellent technical content, making the Journal an important component of membership benefits. I encourage all members, of any background, to consider submitting a paper. The Call for Papers is included in this newsletter, and can also be found on the INCOSE website (http://www.incose.org).

One of my objectives for 1998 has been to foster investigation into important but somewhat neglected aspects of systems engineering that have the potential for high payoff in the future. I was pleased to see papers at the symposium addressing the theoretical underpinnings of systems engineering, particularly with respect to requirements. These are tough topics and often seem abstract, but they are pathways to the future.

A similar, often neglected, area of investigation is: How much of each systems-engineering-related process is appropriate for products that are not technically complex or do not have complicated support and disposal requirements? How much process implementation is appropriate for a small development effort in its early stages when there may be only three or four people working the effort? The tongue-in-cheek form of the question is: How much SE is appropriate for developing Beanie Babies? Most systems are not particularly complex, but they can benefit from the application of systems engineering principles. We must be able to explain to prospective "clients" how to tailor systems engineering to the needs at hand.

Another of my objectives for the year is increased INCOSE participation in the conferences of sister professional societies. For example, the Seattle Metro Chapter is co-sponsoring the Digital Avionics Systems Conference in October. INCOSE is responsible for tracks at the NDIA (U.S. National Defense Industrial Association) Systems Engineering and Supportability Conference in September and at the Software Technology Conference next May. Also, some members of the Detroit/Tri-State Chapter are considering a track for an upcoming Society of Automotive Engineers conference. We should venture into more cooperative arrangements in the future. It will help spread the word on systems engineering benefits.

Progress in system engineering is what we are all about. We achieve that, in part, by sharing our successes and failures with each other. INCOSE symposia and regional conferences are vehicles for such sharing. The next regional INCOSE conference is SE98 in Canberra, Australia, in November. I look forward to seeing many of you there.



Working Groups

CAWG to define criteria for "INCOSE Authorized Lead Systems Engineering Assessors"

Don E. Barber, don.barber@cas.honeywell.com

Over the last nine months, there has been a significant amount of discussion around INCOSE's role in supporting EIA/IS 731, the Systems Engineering Capability Model (SECM). With the release of EIA/IS 731, a merger of EPIC's Systems Engineering Capability Maturity Model (SE-CMM) and the INCOSE's Systems Engineering Capability Assessment Model (SECAM), the Compliance Assessment Working Group (CAWG) will no longer support the SECAM, and SECAM users should migrate to the new model.

In order to help ensure that assessed organizations get quality systems engineering assessors and assessments, INCOSE is establishing a program to authorize lead assessors for systems engineering assessments (also called appraisals). This plan will be targeted at EIA/IS 731 and, in the future, the systems engineering-related portions of Capability Maturity Model-Integration (CMMI). INCOSE will depend on the consultant community to do the assessments, and those who meet a set of qualifications, including following a set of guidelines, can qualify as "INCOSE-authorized lead SE assessors." This should provide a competitive advantage for those consultants. In addition, INCOSE may list these "authorized assessors" on the INCOSE web page for members to go to for assistance with SE assessments.

The Capability Assessment Working Group has been tasked with developing the set of qualification criteria and assessment guidelines and presenting them to the Technical Board for approval. To accomplish this task, the Compliance Assessment Working Group (CAWG), is extending an invitation to interested INCOSE members to join the CAWG as working members, and to establish this list of qualification criteria and qualification mechanisms. Review comments will be sought from INCOSE's Corporate Advisory Board companies.

As of this writing, the proposed timeline includes identifying working members for this project by September 15, and convening the CAWG by email or teleconference to develop plans for creating the criteria and qualification mechanisms by the end of September. From October through December, the CAWG will develop the recommended list of criteria and guidelines (i.e., how one goes about getting qualified, documentation submittal and review, etc.). Toward the end of this period, the drafts will be sent to CAB members for review. In January 1999, the CAWG will present the full program to the Technical Board at the International Workshop. This would include an implementation plan for web pages, announcements, and a schedule for qualifying the first few applicants, as well as plans for periodic additional qualifications.

If you are interested in participating on this new and exciting project, contact the Capability Assessment Working Group chair or co-chair as soon as possible at the following e-mail addresses:

- Don Barber, don.barber@cas.honeywell.com
- Bill Mindlin, wjmindlin@west.raytheon.com

Measurement Working Group Has Significant Numbers in Vancouver

Garry Roedler, Chair, garry.j.roedler@lmco.com
Don Gantzer, Co-chair, Don.Gantzer@faa.dot.gov

The MWG held two working group meetings at the 1998 INCOSE Symposium. During these meetings, Don Gantzer (TRW) replaced Patrick Antony (Boeing) as one of the MWG co-chairs, and eight new members joined the MWG. The new members included Brooks Nolan (Raytheon), Jim Knauss (Northrop Grumman), Johnnie Walker (Honeywell), Bruce Allgood (USAF, OO-ALC), Joe Jarzombek (USAF, OO-ALC), Mark Steffel (NIMA), Bruce Williams (NIMA), and Chris Cheetham (DoD). The MWG is looking forward to a productive association with these new members.

Garry Roedler (Lockheed Martin Management and Data Systems) briefed the results of the Practical Systems Measurement workshop that was conducted during the previous week. The Practical Systems Measurement project is a collaborative effort between the MWG and the PSM initiative (of the Office of the Under Secretary of Defense for Acquisition and Technology). This project has completed the determination of systems related issues, measurement categories, and measures that will aid measurement practitioners in the selection of applicable measures for their projects. The MWG was in unanimous agreement with the results briefed. The next steps are to develop detailed definitions of the measures, as well as indicator examples and case studies. The goal is to have this information completed and integrated with the successful Practical Software Measurement guidance for release in early May 1999.

Dr. William Farr (Naval Surface Warfare Center) provided an updated overview of the Metrics Information Systems Tool (MIST). This tool is the product of NSWC in collaboration with the INCOSE MWG. All recommended enhancements have been

incorporated into the tool. The final beta version was provided to MWG attendees and is available to INCOSE members for review upon request. It will also be added to the MWG web page. During this discussion, Bill also provided status on some other public domain measurement tools that are available or in development. These included the following tools:

- *Statistical Methods for Estimating Reliability Functions in Software/ Systems* (SMERFS3) which is a tool to aid the evaluation of software, hardware, and systems reliability. Employing recent research and modeling inputs from JPL, NASA, the Navy, and the Army, SMERFS3 incorporates 11 software models, seven hardware models, and two system models to perform a system assessment. The tool is Windows-based and there will be a prototype release later in Fiscal Year 1998.
- *Evaluator,* which enables the evaluation of a complex system design by integrating qualitative and quantitative indicators of the system. It incorporates the analytic hierarchy process for weighting the indicators and expert knowledge for the evaluation.

Peter Baxter (Distributive Data Systems) and Chris Miller (Lockheed Martin Management and Data Systems) led a review of a project plan for the establishment of measurement tool requirements. The outcome of this review included the definition of milestones for the project. The next set of measurement tool requirements should be provided to the Tools Database Working Group this fall. These requirements will build on those previously defined, as well as those derived from recent questionnaires and MWG meetings. The project plan was approved by the MWG and received recognition from the Technical Board Chair as exemplary.

Each quarter the MWG selects and publishes two Frequently Asked Questions (FAQs) from its repository of FAQs. In support of this ongoing effort, Ken Stranc (Litton/TASC) solicited review and comment of all FAQs in the repository prior to the meetings and led a review of the repository in order to refine and prioritize them. These FAQs will be posted in their entirety on the MWG web page and continue to be a technical addition to the ***INSIGHT*** newsletter.

The MWG is committed to providing an improved and useful web page for the INCOSE community. Content, development, and maintenance of an improved MWG web page were discussed and steps were taken to make it happen directly after the conclusion of the symposium. Peter Baxter will be working with Valerie Gundrum (Lockheed Martin Federal Systems) to complete this work.

Don Gantzer (TRW) presented a review of measurement requirements and implications in the emerging systems engineering standards and models (EIA 731, 632). This very informative briefing provided insight into measurement requirements in the future systems engineering environment. As a result of this discussion, the MWG decided it should take a more active role in review and comment of applicable future standards and models with respect to measurement requirements. This will begin with the work being done for the Integrated Capability Maturity Model (CMMi) effort.

In order to seize an opportunity to act on the decision from the previously mentioned standards discussion, Joe Jarzombek (USAF, OO-ALC) presented an overview of a draft proposed CMMi Measurement & Analysis Process Area. Several members of the MWG provided comments to Joe prior to or shortly after the conclusion of the symposium. The MWG intends to stay involved in any developments related to this potential process area.

Two lessons learned briefings were provided for the MWG members to share experiences and ideas:

- Experience in Implementing Executive Level Metrics at the FAA from Don Gantzer
- An Apocryphal Metrics Case Study from Dorothy McKinney (Lockheed Martin Missiles and Space)

Finally, the MWG planned for its next major task. The MWG will be coordinating the theme for winter edition of ***INSIGHT.***

For more information regarding the INCOSE Measurement Working Group, contact:

Garry Roedler (Chair), (610) 531-7845, garry.j.roedler@lmco.com; Jeanmarie MacLean (Co-chair), (978) 858-4927, Jeanmarie_Maclean@res.raytheon.com; or Don Gantzer (Co-chair), (202) 651-2288, Don.Gantzer@faa.dot.gov.

Systems Engineering Pattern Language

Bob Barter, barter1@llnl.gov

Pattern languages were first developed in the 1970s as a way to tie together the wide range of design elements found in the field of civil architecture. In the early 1990s, pattern languages began to appear in the field of software development. Patterns, pattern languages, and pattern maps are an effective means of capturing large, complex bodies of knowledge.

Anyone interested in participating in a Special Interest Group devoted to Systems Engineering Pattern Languages is encouraged to contact Bob Barter (barter1@llnl.gov).

Additional information can be found on the San Francisco Bay Area Chapter web page at: http://www.relay.net/~lew/sepl.html

Measurement: Frequently Asked Questions

Ken Stranc, kjstranc@tasc.com

Question: *What insight will measurement give me that I cannot get from first-hand assessments provided by members of my project team?*

Response: Measurement provides an objective, not subjective, view of the state of your project. Data collected over time may be used to calibrate and validate your team's ability to understand and interpret the status, risks, and priorities of the project. The more automated you can make the process of data collection, analysis, and reporting, the more objective the measures will appear to the measurement stakeholders.

The integration of measurements that are taken over time shows trends from which you may make projections of future performance. When the trends are not favorable, there is generally an opportunity to take corrective action early enough to avoid unpleasant consequences. In addition, historical measurements provide the basis for creating estimates for new work of a similar nature.

Measurement data collected for a project can be compared with established control limits based upon the past performance of similar programs or upon contractual requirements. As long as the value of a measure remains within those control limits and does not show a trend toward moving beyond them, the project does not need management action.

As an added benefit, when you and your management are asking for measurement reports, your subordinates are more motivated to address the issues under scrutiny before management action becomes necessary. This results in recommendations for improvements from within the project team. It also promotes higher quality products.

Question: *How do I decide when measurement results indicate that there is a problem that merits further investigation or corrective action?*

Response: There is no "right" answer to this question because variations between planned values and actual values must be interpreted within the context of the project. This interpretation is certainly dependent upon the project's risk tolerance. In most cases, knowing when something has become a "bad enough" problem is readily obvious. People consider not just a single current reading in taking an action, but rather use the "preponderance of evidence" approach and analyze what the trends suggest. Thus, a single indicator is not used to automatically initiate corrective action, but it may instead suggest that other indicators and program data should be reviewed and analyzed very closely to determine whether trends exist that validate the concern.

Many organizations may set "rules of thumb" based on internal historic data or industry benchmarks for certain issues and indicators. For example, a common rule of thumb for information system development is to pay special attention to any indicator with a 20% variance overall or a 10% variance in any period. These figures may be much different for other industries.

Equal in importance to the selection of appropriate measures are the definitions of acceptable ranges for those measures. Certain warning and danger levels should be established early because they represent control limits that define when the entity being measured is in or out of control. The values taken by a measure can be continually compared to the associated control limits to determine objectively whether the project, process, or product is under control. Failure to establish these warning levels early in the project will significantly reduce the effectiveness of the measurement program with respect to its ability to provide early insight into potential problems.

Department of Energy Interest Group

Sam Rindskopf, M.Sam_Rindskopf@ notes.ymp.gov; Norm Cole, ncole@inel.gov

The DOE Interest Group's mission is to foster the application of good systems engineering practices within the U.S. Department of Energy Complex. Our charter is to:

1) Provide a forum for the exchange of systems engineering information, requirements, good practices, methods, lessons learned, and other related systems engineering data among those applying systems engineering at DOE locations.
2) Develop and adapt systems engineering methods, training approaches, and technical approaches that are unique to the application of systems engineering towards meeting the goals of the DOE.
3) Assist those interested in the implementation of systems engineering principals in the DOE complex.

This interest group is comprised of representatives from both the DOE and its contractors, who represent various interests across the DOE complex. These members meet twice per year, during the international symposium and the international workshop. In between these events, the group communicates using email and conference calls.

The goals for this interest group include the development of a systems engineering application profile related to waste management. This profile will become a part of the collection of profiles published by the INCOSE Systems Engineering Applications Technical Committee. In addition, the group has drafted a generic Systems Engineering Management Plan. In the longer term, members will be identifying additional products that will aid the DOE community in the application of systems engineering.

INCOSE VANCOUVER

PEOPLE, TEAMS '98 AND SYSTEMS

The Planning Committee wishes to recognize the contributions of the INCOSE '98 PATRONS whose support made the Symposium's overwhelming success possible.

The Boeing Company

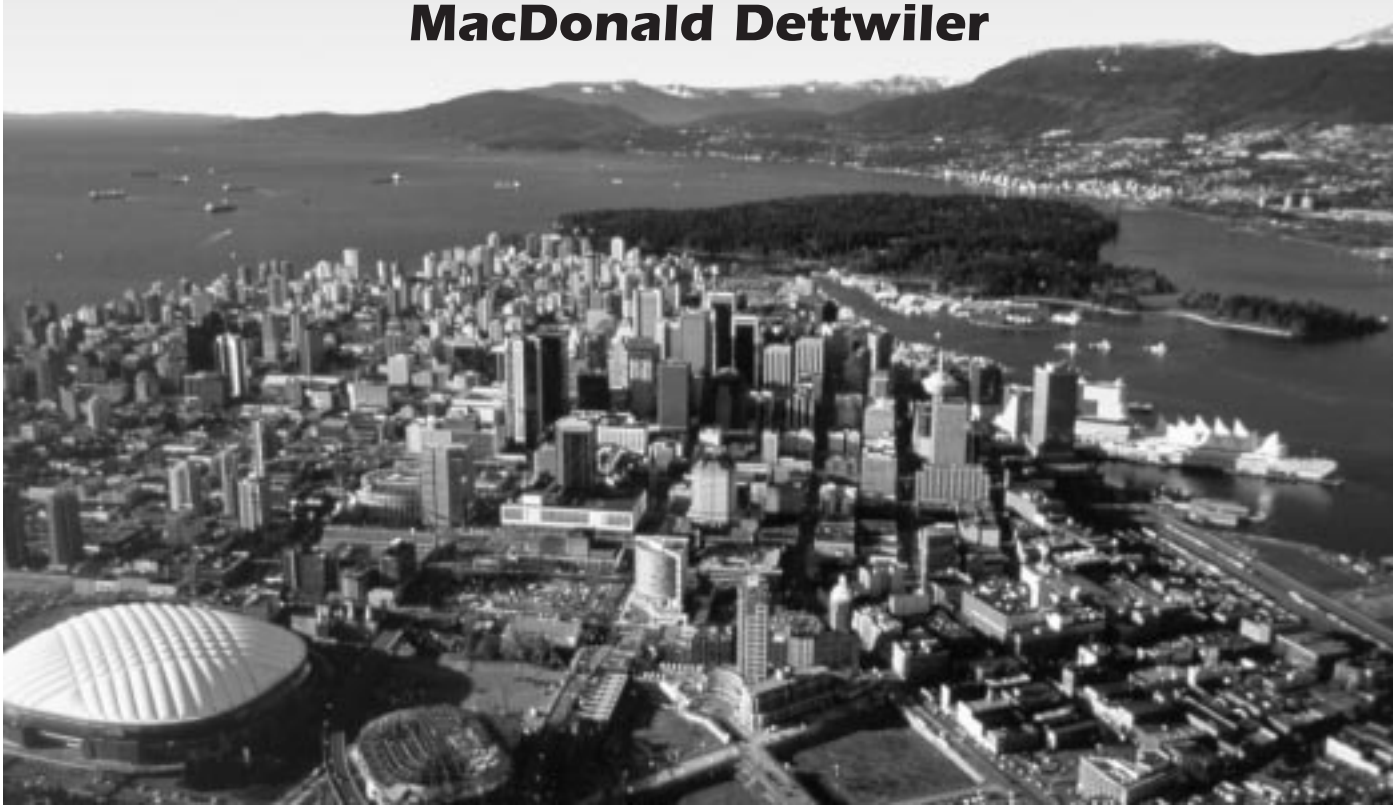
Raytheon Company

AlliedSignal Inc.

Rational Software Corporation

The Aerospace Corporation

MacDonald Dettwiler



INCOSE '98 in Beautiful Vancouver

Kal Toth, ktoth@datalink.net

By all accounts, INCOSE '98 was a smashing success: inspirational speeches; a comprehensive technical program; a plethora of highly entertaining social events and hoopla; terrific exhibits and tours. With the incredibly beautiful backdrop that only Vancouver can offer, these factors combined to produce a truly unforgettable event. Comments from our attendees like: "a successful and exciting conference," "a superb and enjoyable symposium" and "the very best INCOSE conference ever!" confirm that INCOSE symposiums are getting better every time, and that they are bringing more and more solid value to our membership.

Most events were held at the Hyatt Regency in downtown Vancouver, while the exhibits, lunches and certain receptions were held across the street at the Hotel Vancouver. Some 40 vendors and organizations did a first-class job of presenting, explaining and demonstrating their products and offering. The successful staging of our exhibits program was clearly a significant success factor for INCOSE '98. By the same token, Raytheon's air traffic control tour, MacDonald Dettwiler's tour of remote sensing technologies and JPL's virtual design center tour for engineering space mission projects were vital to the symposium's success.

Our keynote speaker, Dr. John MacDonald, Chairman of the Board at MacDonald Dettwiler and Associates, and one of Canada's recognized technology sector leaders, launched the main event at the first plenary with insights and wisdom that only a dyed-in-wool systems engineer can bring to the table. (Dr. MacDonald's speech can be read on the INCOSE wedsite.)

During the lavish banquet, Nisga'a dancers aroused the masses with their colorful native costumes, chants and music, getting some 900 attendees to their feet emulating wolves, eagles and killer whales (a sight well worth the admission price alone!).

Chief Leonard George, with Jas and Bibi Virdi Madhur before banquet

This was in preparation for our guest speaker, Chief Leonard George, who wove native, contemporary and technological images with mystical thought and hope...inspiring us to reflect about our personal and working roles in society.

At the Wednesday plenary, Michael Schrage, internationally renowned author and visionary, applied his technology roots and media background to help us better understand the tools and dynamics of successful collaboration in business and technology. Using humorous comments, engineering terminology and meaningful stories, he illustrated the impact of our systems engineering paradigms on our ability to be honest with ourselves. With apologies to Winston Churchill and Marshall McLuhan, he offered the following highly relevant epigram: "We shape our models, and then our models shape us."

Ivy Hooks during her tutorial

Perhaps the most remembered highlight of INCOSE '98 will be the harbor dinner cruise which featured a spectacular fireworks display which left stars in many peoples eyes, we are sure. An added bonus was a rock-&-roll jam session led by one of INCOSE's stalwarts, and supported by an enthusiastic rag-tag cast of amateur vocalists who raised the roof and managed to return to shore without any casualties.

The technical sessions, meanwhile, reinforced the "People, Teams and Systems" theme of the symposium, and the ongoing "internationalization" of INCOSE. The Monday tutorials were booked to capacity and very well received and covered topics ranging from requirements and architecture, to models and cross-cultural issues.

The Academic Forum, also on Monday, was very well attended. It was gratifying to see a heterogeneous mix of academics and commercial practitioners discussing technical issues of common interest including existing and planned SE programs, SE needs of industry and the centers of excellence initiative.

The technical papers were of first-grade quality. Over 100 papers were presented covering six tracks, in the areas of processes, through models, tools, management, metrics, applications and education. Perhaps the most "noticed" paper entitled "How Maturity

Jim Armstrong hits a home run

Modeling Saved My Softball Team" used live animation and a period costume to get its message across.

All six panels were well attended proving once again that this format is very popular with our attendees. Topics included an update report on the state of Capability Maturity Assessment; a broad coverage of system complexity issues and solutions; and a discussion of current systems engineering education and research activities, including a report on progress and directions for the emerging systems engineering center of excellence.

The Thursday morning plenary proved to be a truly great success confirming that our membership is very keen about following the international scene. The first plenary, "People, Teams and Systems, Across International Boundaries" brought together industry leaders from Australia, Canada, the European Space Agency, the UK and the USA to discuss their experiences in dealing with teaming, management, and cross-cultural issues. The second panel summarized the most significant outcomes of the First Joint European Space Agency/INCOSE Conference which was held in the Netherlands last fall and focused on "faster, better and cheaper" systems engineering. This session turned out to produce the perfect closing statement for INCOSE '98. It gave the audience plenty to think about and a warning that they better be prepared, with bags packed, for an even better symposium in Brighton, England next June! See you there!

1998 INCOSE Symposium: Statistics on Parade!

Ellen Barker, nelle@u.washington.edu

INCOSE's Eighth Annual International Symposium—July 26–30, 1998 in Vancouver, BC Canada—was truly a memorable event and our first symposium outside of the United States. For those interested in the numbers, here is a mini statistical profile:

In keeping with our international focus, we continued to attract participation from outside the U.S., with 194 attendees spanning 14 countries and 94 companies (24.5% of the 792 total). This is a significant rise from the 1997 symposium, where the non-U.S. attendance was 87 people. Previously unrepresented countries increased, and there were first time participants from Belgium, South Africa, and Taiwan.

Attendance from the newly redefined INCOSE regions was as follows:

- Region I (Northwest North America), 21.6%;
- Region II (Southwest United States), 26%;
- Region III (Europe), 11%;
- Region IV (Northeast North America), 16.8%;
- Region V (South America, Central America, Southeast United States), 21.6%;
- Region VI (Australia, Asia, Africa, Middle East), 3%.

California continued its annual lead in the category of "Percentage of Participants by U.S. State" with 17.8%. The 598 U.S. participants represented approximately 175 companies.

Of the 175 initial papers submitted, 112 were chosen for presentation and 17 as supplemental papers. This represented 208 authors and 103 companies. Five lively and provocative panel sessions were offered this year, spanning a range of topics including CMM integration, education and research, computer-based complexity, and international cooperation. In the professional development arena, 414 people took advantage of the eight tutorials plus the academic forum. The three technical tours—the Vancouver Air Traffic Control Centre, MacDonald Dettwiler and Associates, and the JPL Virtual Tour—were extremely popular, drawing 174 participants. This year's special event, the Harbor dinner cruise and fireworks display, attracted a record 520 guests.

The exhibits program included 34 companies comprising 200 exhibitors demonstrating their wares. Also available to provide information was the 1999, 2000 and 2001 INCOSE symposia hosts, plus the INCOSE Central and Working Group booths that included sample work products for members to peruse, and answered questions about the organization and the symposium.

Many people took advantage of the symposium to join INCOSE or renew their membership. This year's totals were 239 new and 246 renewing members.

All in all, the INCOSE '98 symposium was a rousing, multicultural event. Thanks to all those who attended for making these statistics possible!

Ellen Barker is recognized for her contributions to INCOSE

A Tool Peddler's Thoughts on the Symposium's Organization

Bob Needham, bobneedham@compuserve.com

For the INCOSE '98 Symposium in Vancouver, Canada, 3SL (Structured Software Systems, Ltd) took the decision to attend on the basis that this was probably the single most important gathering of systems engineers this year.

Due to the interest from exhibitors wishing to attend the symposium, the venue had to be split across two sites. The symposium headquarters was the Hyatt Regency Vancouver, while the Exhibits Hall was in the Hotel Vancouver, located just across street.

The exhibition was held in one of the Hotel Vancouver's ballrooms and accommodated a variety of exhibitors, with adequate space between booths to allow people to stop and discuss items of interest, or just catch up with old acquaintances.

The basic booth size was adequate for companies with little or no equipment to demonstrate. However, a number of organizations took multiple units in order to have sufficient space for their equipment. In order to provide the fullest exposure to Cradle, 3SL took a basic unit to provide the initial contact, along with a suite on the 4th floor, so that we could also provide a demonstration of our software. This proved immensely successful as it kept our stand clear for this initial contact, while providing a comfortable, private environment, free from interruptions, for those who wished to learn more about the product and see it in action.

Attendance at the exhibitions was sporadic, the bursts of activity obviously coinciding with the breaks in the technical program. The exhibition hall officially opened at 3:00 PM on Monday, and there was an initial surge of people doing a quick sweep to see who was there and what faces they knew. Tuesday was the first full day for the Exhibits Hall, as well as the opening of the symposium paper sessions. As a result the morning was slow. But, the arrangement to have box lunches in the Exhibits Hall brought delegates in. Also, there was an official social hour in the hall before the start of the evening banquet. This proved exceptionally beneficial. Symposium attendees mingled with exhibitors, either discussing their products, or chasing the trays of drinks and food circulating around the booths.

By far the most profitable day was Wednesday when there was an exclusive exhibition time from mid-morning until lunch, with a box lunch also being served. It was during this day that we saw an increased interest in demonstrations, which continued throughout the day until the Exhibit Hall closed at 4:00 PM.

Initially the idea of a split site symposium filled us with some trepidation, fearing low attendance at the exhibition. However, the closeness of the hotels and the way the program was organized, with the provision of food at the exhibition hall, as well as dedicated exhibition time, ensured that the majority of attendees came over and viewed the booths.

All in all, as far as 3SL were concerned, the symposium was deemed a great success. The three days of exhibition allowed everyone time to view the products on display and get a deeper insight into areas of interest. The quality of attendees was very high and we look forward to repeating the same success when the symposium moves to Brighton, England, in 1999

INCOSE '98 Best Papers and Student Awards

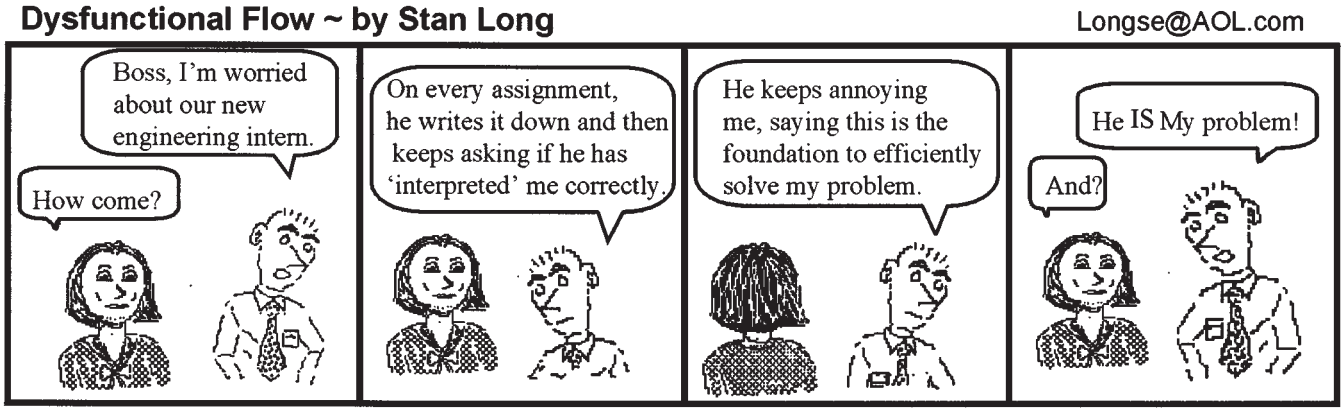
Kal Toth, ktoth@datalink.net

The following papers and authors were selected through the paper peer review process as Best Papers for the symposium.

- **Ralf Hartmann**, "System Engineering Process Definition as Part of the European Cooperation for Space Standardization (ECSS)" (Systems Engineering Management track)
- **Michael Woodhead, D. Priestley**, "Synthesis of an Anti-Terrorist Air Transportation Security System" (Processes & Methods track)
- **Gregory Worden**, "New Academia: Computer-Based Distance Learning-Case Study" (Education & Research track)
- **E. (Rich) Widmann, W.J. Mindlin**, "Economical Approach to Conducting Assessments of Systems Engineering Capability" (Measurement track)
- **Julian Johnson**, "SEDRES Project: Producing a Data Exchange Standard Supporting Integrated Systems Engineering" (Modeling & Tools track)
- **John Applegate**, "Systems Engineering in Developing Nations" (SE Applications track)

The following students were provided support and are recognized for their important contributions. They received complementary registration, hardcopy proceedings, and other gratis items, plus a small honorarium to defer their expenses to attend.

- **Tyson Browning**, "Sources of Schedule Risk in Complex System Development"
- **Kendra Cooper (with Mabo Ito)**, "Advantages of Stimulus Response Requirement Specification Techniques for System Testing"
- **Michael Donat (with Jeffrey Joyce)**, "Applying an Automated Test Description Tool to Testing Based on System Level Requirements"
- **Alexander Egyed (with Barry Boehm)**, "Comparison Study In Software Requirements Negotiation"
- **Adam Stone (with Andrew Koehler)**, "System Engineering for Informal Regulation"



Do you have ideas for Stan's next cartoon? Contact him at longse@aol.com

News from Chapters

Norwegian Chapter is Emerging

Cecilia Haskins, Chapter Vice President, cha@bdc.no

The Norwegian Systems Engineering Council (NORSEC) has nearly completed the requirements needed to become a chartered chapter of INCOSE. Their efforts were recognized during the 8th annual international symposium in Vancouver.

NORSEC was initiated in June of 1997, but only this year submitted their petition to join the ranks of INCOSE. Seven members of the chapter were present in Vancouver, including the Vice President, Program Committee Chair and SFK representative to the NORSEC Board of Directors. The chapter hopes to reach the 25-member mark by the end of September, and hold its first official INCOSE NORSEC meeting on 25 September 1998. The program will consist of first hand reports of the symposium by those who attended. This and future meetings are held on the NTNU campus in Trondheim. Anyone wishing to attend future meetings may coordinate their arrangements with Odd A. Asbjornsen or Truls Gundersen, fax + 47 73598390.

NORSEC encompasses all of Norway and hopes to be an active leader in sponsoring the growth of INCOSE in Scandinavia. Norwegian membership will include SE practitioners in the fields of energy and marine applications. The chapter is striving to make valuable contributions to the Applications Working Group. With strong university backing, chapter members have also targeted participation in the Education and Research Working Group. Close geographic proximity to the UK means that the chapter plans to attend and support the symposium in Brighton next June.

San Francisco Bay Area

Lew Lee, President, lew.lee@trw.com

Our chapter is overwhelmed with the response to our *INCOSE Systems Engineering Handbook*. We have received word from the INCOSE Office that in the first few months of its publication, over 200 copies have been sold. Please get a copy and share the knowledge of its existence with your colleagues. We look forward to receiving critical feedback to help us in crafting the next release. Tim Robertson, handbook senior editor, appreciates your kudos and comments. He can be reached at timr@sirius.com. To purchase your copy, contact the INCOSE Central Office (see contact information on page 3). The handbook is $20 for members and $25 for non-members.

Monthly meetings continued through the summer months for us in Silicon Valley. In June, we enjoyed a presentation on "Total Partnership with Your Customer" from Tom Morton, Vice President and Chief Engineer at Lockheed Martin Missiles & Space. July saw our chapter's first topic-based networking evening led by Dorothy McKinney, Director of Mission Success at Lockheed Martin Missiles & Space, and President-Elect of the chapter. The topic we selected was "How To Use Systems Engineering To Reduce Program Risk While Producing Products Better, Faster and Cheaper." It proved to be a lively evening and offered our members and guests an extended opportunity to improve their professional network.

Bob Barter of Lawrence Livermore National Laboratory presented an expanded presentation of his Vancouver Symposium paper, "A Systems Engineering Pattern Language." Bob envisions an interest group starting up to address an SEPL. Bob can be contacted at barter1@llnl.gov. There is also a short article from Bob on page 19.

Following the tremendous success of three years of organizing tutorials, the chapter's Board of Directors will formalize the tutorial program by introducing a "core series" of tutorials to be offered on a regular basis. This is expected to benefit members as well as the organizations that support us.

Upcoming events for the chapter include:

- October 13, Tentative Topic - Risk Management
- November 10, Bob Otnes, "History and Lore of Slide Rules"
- December 8, Program to be announced.
- January 12, Program to be announced.

All meetings are held at GTE Government Systems in Mountain View at 5:30 p.m. Check our website for announcements and directions: http://www.relay.net/~lew/sfbac.html.

News from Silver State Chapter

Jesse Teal, jesse_Teal@notes.ymp.gov

The chapter completed a series of four dinner speaker meetings in as many months. The June speaker was Dr. Earl Weener, Chief Engineer, Systems Engineering, Boeing Commercial Airplanes. Dr Weener presented data and discussed issues related to commercial aircraft safety. A short video on the Boeing 777 was also shown. The material presented and the ensuing discussion was interesting and very stimulating.

Chapter plans for the remainder of the year include a luncheon general meeting, a dinner speaker meeting, a tutorial, and a holiday season party.

Lastly, negotiations are being conducted with University of Nevada, Las Vegas (UNLV), regarding UNLV/INCOSE joint sponsorship of an International Conference on Systems Engineering in 1999.

German Chapter Technical Program

Herbert Negele,
H.Negele@lrt.mw.tumuenchen.de

The autumn technical program of the German Chapter is planned and organized. You are invited to attend, if in the neighborhood!

October 27:
Topic: "Modellbasierte Entwicklung von Embedded Systems - Dynamische System Modellierung" (Model-based Development of Embedded Systems - Dynamic System Modeling)
Speaker: Peter Fuhrmann and Juergen Weiss, Berner&Mattner Systemtechnik GmbH
Time: 6:00 PM

December 8:
Topic: "Methoden und Werkzeuge fuer eine integrierte Flugzeugentwicklung" (Methods and Tools for Integrated Aircraft Development)
Speaker: Dr. Peter Hurst, Daimler-Benz Aerospace, Military Aircraft
Time: 6:00 PM

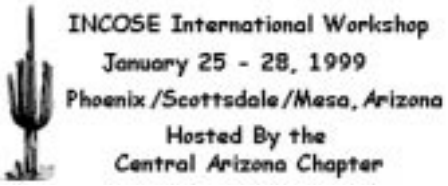
For all presentations:
Place: TU München, Fachgebiet Raumfahrttechnik, Boltzmannstr. 15, 85748 Garching (near Munich)
Contact: Herbert Negele, +49-89-289-16008, h.negele@lrt.mw.tu-muenchen.de

North Star–Upcoming Events

Hugh S. Perry, hugh.s.perry@cdev.com

If you are in the Minneapolis/St. Paul area on any of the following dates, please visit your INCOSE kinfolk at one of the North Star Chapter meetings. Our program for the remainder of 1998 is as follows:

- October 14, Honeywell House visit - a vision of domestic automation for the future
- October 17, Fall tutorial, topic is still being determined
- November 17, Microsoft future technology roadmap, Part 2
- December 10, North Star Christmas Party



Cassandra Fleetwood, Vice President
cassandra.fleetwood@medtronic.com

The International Workshop, hosted by the Central Arizona Chapter, will be held January 25-28, 1999 in Mesa Arizona at the Sheraton Mesa hotel. Meetings will be held in the hotel and the adjacent Mesa Convention Center.

Mesa, Arizona's third largest city, is just twelve miles east of Phoenix Sky Harbor International Airport, and easily accessible from all parts of Phoenix/Scottsdale. The area offers over 120 golf courses, horseback riding, museums, shopping, historic towns, and other convenient recreational activities. The '99 Phoenix Open is being held at the same time as the Workshop.

Invitations will be mailed on October 20. Invitations will be mailed to members of the Technical and Administrative Committees, Working Groups, Corporate Advisory Board, and the Board of Directors. Additional invitations and reminders will be mailed November 16 and December 21 to accommodate committee membership changes.

If you are interested in attending, please contact the appropriate committee chair to request an invitation.

Fee Table - International Workshop 1999

Postmark	By November 25, 1998
Fee	$225
Postmark	November 26-January 25
Fee	$275

For additional information, visit the Central Arizona Chapter web page at http://www.geocities.com/CapeCanaveral/5809 or contact Joe Juarez (joseph.juarez@cas.honeywell.com), International Workshop Committee chair.

Mark your calendars and plan to join us in the "Valley of the Sun" for INCOSE International Workshop '99.

Washington Metro Area

Dona Lee, President, donalee@dynsys.com

The U.S. Congress may have taken its usual recess this summer, but there was no winding down in Washington, DC this year for INCOSE. Not only was the Washington Metropolitan Area (WMA) chapter well represented in Vancouver at the annual symposium, but we managed to continue our tradition of monthly networking/dinner meetings. This summer's meetings provided something for everyone:

1. Allen Levy, Principal Deputy Project Manager from the Department of Energy's Lawrence Livermore National Laboratory, joined us in June. He provided a fascinating overview of ***The National Ignition Facility Project,*** one of the largest and most complex laser projects of its kind, and the most challenging laser-target interaction system ever constructed.
2. The chapter had so many symposium authors-in-residence that our annual symposium paper preview in July had a new twist with dual tracks. We were privileged to be the first to hear these papers:
   - ***Engineering of Complex Systems: Understanding the Art Side,*** Dave Newbern and Dr. Jerry Nolte, TASC
   - ***How Maturity Modeling Saved my Softball Team,*** James Armstrong, Software Productivity Consortium
   - ***Systems Engineering for Software and Hardware Systems: Point-Counterpoint,*** Sarah Sheard, Software Productivity Consortium
   - ***Reconciling Systems and Software Architecture,*** Dr. Mark Maier, Aerospace Corporation
   - ***FAA Investment Analysis – A Systems Engineering Application,*** Bob Fenton, TRW
   - ***Systems Engineering to Sydney,*** Dr. Joseph Kasser, University of Maryland
3. Michael J. Harrison, Acting Director for Architecture and

Systems Engineering, Federal Aviation Administration, joined us in August to provide a lively, frank discussion of National Airspace System (NAS) Architecture, and its use as both the "blueprint" for modernization and for investment decision making to sustain the NAS. Mr. Harrison discussed the processes used in reaching a collaborative system architecture between the FAA and the users, shared experiences gained along the way, and provided an outlook for future work.

The chapter's Saturday tutorial program continues to draw new members into INCOSE. David Long, leading our Tutorial Program, has two tutorials scheduled for the fall: ***System Requirements Analysis,*** presented by Jeff O. Grady, in September, and ***Risk Management,*** in November.

The WMA chapter welcomed a new Program Chair this spring—long-time INCOSE member, Susan Jones from the Aerospace Corporation. Susan, a transplant from the Los Angeles area, is planning some interesting events for 1998/99, including a panel on Risk Management this fall and a December social.

The latest information on WMA Chapter activities is available on the WWW at www.vtcorp.com/wma-incose through the ongoing support of Vitech Corporation. The location for all dinner meetings is provided through the continuing support of Boeing Information Services, 8000 Towers Crescent Drive, Level A Conference Room, Vienna, VA. Networking starts at 6:30 p.m.

Upcoming Chapter Meetings:

- October 13, ***Risk Management Panel***
- November 10, Topic TBD, Dr. Mark Maier, Aerospace Corp.
- December 8, ***Social***

Upcoming Tutorial:

November 7, Managing Risk–A One-Day Tutorial
Presented by Dr. Elaine Hall
Tycon Courthouse, Tysons Corners, VA
POC: David Long, dlong@vtcorp.com,
(703) 883-2270

Midwest Gateway

Don Hess, Secretary, dhess@mdc.com

Two major events for the Midwest Gateway Chapter included a social outing at a St. Louis Cardinals baseball game, and a review of the papers that were presented at the Vancouver symposium by chapter members.

In June, 26 chapter members and their guests attended a St. Louis Cardinals baseball game to watch Mark McGwire's attempt to surpass a long-standing record of 61 home runs in one season. While Mark did thrill us with another home run, the Cardinals lost the game.

Our July membership meeting featured symposium paper presentations by our local members headed to the INCOSE Symposium in Vancouver. Following a lavish spread of hors d'oeuvres, we were treated to very interesting presentations on "Quality Function Deployment" and "Organizational Challenges of Systems Engineering," and a captivating assessment of systems engineering at Boeing by Dr. Vicki Johnson, visiting professor from Embry-Riddle University.

Inland Empire

Petrus.Kaufman, Petrus.Kaufman@trw.com

The Inland Empire Chapter (IEC), located within San Bernardino, CA, in conjunction with the University of California Riverside, would like to announce the following SE course dates and times:

Dates: Sept. 22 - Oct. 1, 1998
Course: *Introduction to Systems Engineering Management*
Place: Riverside, California
Days/Times: Tuesday, September 22 and Thursday, September 24, 6:30-9:30 PM; Saturday, September 26, 9 AM to 4 PM; and Tuesday, September 29, and Thursday, October 1, 6:30-9:30 PM
Fee: $180

Dates: Oct. 7 - Dec. 16, 1998
Course: *Systems Design and Integration*
Place: Riverside, California
Day/Time: Wednesday, 6:30-9:30 PM
Fee: $240

For additional course information or registration contact: UCR Extension at (909) 787-4111, or check the UCR web site: www.unex.ucr.edu.

Announcement **– INCOSE Region II Fall Mini-Conference**
Saturday, November 14, 1998 • San Diego, California, at SAIC

Systems Engineering in the Telecommunications Field

Systems Engineering as a discipline is applicable to systems and endeavors of all kinds. This Mini-Conference will have papers from a broad spectrum of telecommunications Systems Engineering activities. Sample topic areas include the following:

- Telecommunications Systems Architecture Definition and Characterization
- Defining System Requirements
- Structured Re-Engineering of Existing Systems
- Telecommunications Systems Engineering Processes and Practices
- Configuration Management During System Development
- Telecommunications Systems Capability Models
- Integration of New Systems With Legacy Systems
- Deployment of Systems, Including Test and Evaluation
- Telecommunications Systems Engineering Tools and Techniques
- Maintenance Over an Extended Life Cycle
- Telecommunications Systems Engineering Lessons Learned

Paper presentations will be 20 minutes in length, with 10 minutes for questions and answers. Abstracts of selected papers will be provided to attendees, but there will not be proceedings of full papers furnished. For more information, contact: James D. Peterson, jdpete@pacbell.net.

INCOSE Infrastructure

Call for Fellows' Nominations

Terry Bahill, terry@sie.arizona.edu

The INCOSE Fellows Select Committee will be pleased to accept nominations for new INCOSE fellows. Nominations may be made by INCOSE members or by INCOSE fellows.

Nomination packages will be accepted until December 21, 1998. Final discussions by the INCOSE Fellows Select Committee will be held at the INCOSE International Workshop in Phoenix, January 25-28, 1999. This committee will submit a list of recommended fellows to the INCOSE Board for their April meeting. New fellows will be announced at the International Symposium in Brighton, England, June 6-10, 1999.

The INCOSE Fellows Select Committee is composed of: A. Terry Bahill, University of Arizona; Ben Blanchard, Virginia Tech; George Friedman, University of Southern California; James Martin, Raytheon Systems Co.; Andy Sage, George Mason University; Richard Stevens, Quality Systems & Software; and A. Wayne Wymore, University of Arizona. Please submit Fellows nomination packages and requests for the Letters of Support form to:

Terry Bahill
Systems and Industrial Engineering
University of Arizona
1127 East North Campus Drive
Tucson, AZ 85721-0020
terry@sie.arizona.edu

The following is the official INCOSE Fellows Award Policy approved at the January 26, 1998 INCOSE Board meeting.

1) Fellows are intended to be treated as a level of membership by INCOSE. The Membership Committee shall define privileges and duties of this level. Selection of Fellows shall be by the Board of Directors upon recommendation of a Fellows Select Committee.

2) **Fellow Award Eligibility**
Candidates must have been INCOSE members for a minimum of 5 years. Under exceptional circumstances, this can be waived by the Board of Directors.

3) **Fellow Award Criteria**
Fellow awards are based only upon significant verifiable contributions to the art and practice of Systems Engineering, and only upon evidence of same provided in written form to the Fellows Select Committee provided by their nominators.

It is recognized that systems engineers come from different domains, e.g.: industry, government and educational organizations. They also are engaged in different areas of practice, including research, application and teaching. In some cases, national security or company policy inhibits accessibility of supporting materials. Therefore, varied verifiable evidence of contributions to the state of the art and practice are expected to be submitted.

Nominators should identify their candidate's primary strength as that of either a practitioner (applies knowledge), or a researcher (develops new knowledge), or a teacher. For a practitioner, the criteria are satisfied by providing evidence about programs that he/she has personally led and/or advanced by means of significant application of the systems engineering art. This evidence should be supported by publications—ideally in refereed journals or conferences where possible—or other suitable means. For a researcher, the criteria are satisfied by providing evidence about research personally conducted or advanced as a consequence of the researcher's effort. This evidence should be supported by patents, patent applications, books authored and those to which contributions have been made, and publications in refereed journals or conferences. For teachers, evidence is provided by advances made in the state of the art in systems engineering education such as new books, courses, curricula and refereed publications.

Some nominators may wish to submit their candidates for consideration in more than one category. In this case, evidence must be provided as above for every applicable area.

4) **Fellow Award Process**: Each candidate will have a nominator other than him or her self. The nominator will provide a package to The Fellows Select Committee that will consist of the following:

a) Candidate Profile:
- Name of Candidate
- Age
- Primary Contribution
- Secondary Contributions (if applicable)
- Educational Background
- Professional History (Employer, Years of Employment, Duties, Accomplishments)
- Accomplishments vs. Fellows Criteria

b) Letters of Support should be provided by the nominator and at least three others. In the future, all of these should be Fellows of INCOSE or related professional societies, and should state so if this is the case. These letters are limited to two typewritten pages, and should provide:
- Name of Nominator or Supporter
- Brief educational and professional background of Nominator or Supporter

- Professional society memberships and position if any in these, such as Fellow
- Basis of knowledge about the candidate
- Evaluation of the candidate vs. the criteria
- Rating of the candidate as an INCOSE Fellow on a scale of 1 (low) to 10 (high)

Those writing letters of support should have the candidate's resumes available to them, but each letter of support should be independently written.

The committee intends to have a standardized form for Letters of Support. Nominators should request these forms before submitting their nominations.

Ways & Means – By-Laws & Policies

Joe DeFoe, JaySeedy@aol.com

I'm pleased to have accepted Bill Schoening's offer to become the Ways and Means Chair. I'm looking forward to sustaining and building upon the fine base built by my predecessors.

I want to begin by reminding all the committees that we operate under the authority granted us by the members, through the INCOSE By-Laws, and by the Board of Directors, through the INCOSE Policies. Prior to Symposium'98, not all the current policies were available from the web site, but were available in Microsoft Word from either the INCOSE Central Office or from me. At present, the By-Laws are available in a single HTML document from the INCOSE web site. You may find it convenient to "Save as…" both documents from your browser for quick reference when it is not convenient to go online. Of course, you will have to remember to refresh your local copy after each update—usually in February and August.

As we all work towards the goals of INCOSE, it is often the case that a committee will recommend actions that will require changed or new policies, or modifications to the By-Laws. As an *ex-officio* member of Ways & Means (see policy WMC-100), it is the responsibility of the committee recommending an action to bring to the Board both the proposed action and the recommended changes or additions to the affected policy or By-Law. It is my responsibility as chair to assure the Board that Policy and By-Law issues have been addressed by proposed committee actions. For the upcoming International Workshop in Phoenix, this means that you need to send me your proposed changes and additions in November and December, so that the Board has all the information they need to consider your recommendations.

Of course, Ways & Means has responsibilities other than maintaining the by-law and policy baseline. At our symposium meeting, Bill Schoening made suggestions as to how this committee can be better structured to assure that all INCOSE strategic, tactical, and financial plans are kept current and consistent. As a result, I am working on an update to WMC-100 to refine the charter and structure of W&Ms. I will be sending my recommendations to the W&Ms members in the fall.

James N. Martin Appointed Chair of Standards Technical Committee

William Schoening, wschoening@mdc.com

I have appointed James N. Martin as Technical Committee Chair for INCOSE's Standards Committee. James is one of the founding members of INCOSE (Member #76) and has been active in numerous capacities. James has demonstrated the combination of leadership skills and technical expertise important to his new role on the INCOSE Technical Board. He was the founder and first chair of INCOSE Requirements Management Working Group, and served on the INCOSE Board of Directors. He was co-founder and Director of the Liberty Chapter, and now serves as a Director of the North Texas Chapter. James is the author of numerous papers on systems engineering and author of a textbook, "Systems Engineering Guidebook" with another in progress.

James also served as EIA G47, vice chair (1994-95) and chair (1996). As chair of the EIA 632 Working Group, he has led the effort to author and release the EIA Standard 632, Processes for Engineering a System. It is no coincidence that James and many of the other systems engineers on that committee are also members of INCOSE. He has demonstrated his ability to lead a cross-industry team with initially divergent views, and bring the product to fruition. EIA 632 is in balloting, and we are waiting the results to see if it has been approved.

On behalf of INCOSE, I would like to express my appreciation to the Raytheon Systems Company for supporting James in his work for INCOSE.

INCOSE Board Approves Dues Change

Tom Kabaservice, tkabaser@harris.com

The INCOSE Board of Directors approved an increase in the annual member dues from $60 U.S. to $80 U.S., effective with the membership year that begins in June 1999. This is the first increase since INCOSE was founded in 1991.

Significant new member benefits have been added over the past few years, including quarterly issues of an updated ***INSIGHT,*** an extensive web site, and quarterly issues of the Journal of *Systems Engineering*. The Journal costs $30 per year for each U.S. member, and an additional $10 per year for mailing outside the U.S. These expanded benefits are the primary reason why per-member costs have grown to the point that we have a deficit for the current fiscal year.

A committee has studied the level of member dues for almost a year. Headed by Tom Kabaservice, Region

Full Page Ad
for Ascent Logic

V Director, the committee included representatives from the chapters, membership committees, and U.S. and non-U.S. members. They studied comparable professional societies and looked carefully at INCOSE's financial situation for the years ahead. Even at $80, INCOSE membership remains a bargain compared with other international technical and professional societies.

Member dues contributions will continue to support chapter activities at current levels. Individual member dues will continue to represent less than half of the total income required to sustain INCOSE's activities; for the rest, we will continue to depend on the support of our Corporate Advisory Board members, and on the financial success of the annual International Symposium.

We hope that this information helps you understand why the Board of Directors regards this dues increase as essential to the future of INCOSE.

"What's in it for me?"

Membership Co-Chairs: Lew Lee, lew.lee@trw.com, Dona Lee, donalee@dynsys.com

One of the most enjoyable tasks of being the Membership Co-Chairs is publicizing the many benefits that INCOSE members receive to support their professional life. INCOSE produces a variety of tangible products and services that many members find indispensable in the workplace. Some examples are the World Wide Web discussion list (incose-discuss), on-line tool databases, symposia proceedings, and technical guides and handbooks. What members appreciate is the quality of the information contained in these products and services, and INCOSE's commitment to making them available at little to no cost. To produce such useful results solely through the efforts of volunteers is very rare. It is evident that these products are labors of love. It is only through an organization such as INCOSE that we are able to bring together both novice systems engineers and experts from a rich mix of workplace cultures to collaborate and develop these technical products and publications.

But in answering the often-asked questions, "Why should I join INCOSE?" or "What's in it for me?" we find, as Membership Chairs, that our answers depend on the uniqueness of the individual asking the question. We come into contact with systems engineers with very diverse backgrounds, having varying levels of education and experiences. INCOSE resources assist each in a different way. Members can be students, practitioners, contributors, or teachers. Students, for example, find INCOSE products readable and informative. As another example, the discussion list provides an opportunity to ask questions of other practitioners. Practitioners are offered a forum in which ideas and lessons learned can be exchanged and refined, and information is available on the latest standards activities that impact the systems engineering professional. Potential contributors to the SE body of knowledge, aided by INCOSE's technical working and interest groups, are given the opportunity to develop handbooks, guides and survey tools. Development of a Journal or symposium paper is also a popular information outlet. Finally, teachers have the opportunity to interact with others who are willing to be engaged and challenged through a variety of venues, including symposia and chapter-sponsored tutorials.

U.S. President Calvin Coolidge (1872-1933) once said, "All growth depends on activity. There is no development, physically or intellectually, without effort and effort means work." INCOSE provides abundant opportunities for those who wish to continue to "grow" as systems engineers. Members who make the "effort" are assured professional and personal growth, and the recognition and satisfaction that comes with advancing the systems engineering discipline. Be part of the progress.

Sarah Sheard Appointed New Chair of Measurement Committee

William Schoening, wschoening@mdc.com

I would like to announce the appointment of Sarah Sheard as Technical Committee Chair for INCOSE's Measurement Committee. The Measurement Committee currently encompasses the Metrics Working Group, chaired by Garry Roedler; the Capability Assessment Working Group, chaired by Don Barber; and the SE Reengineering Working Group, chaired by Jerry Fisher and Jack Fisher.

Sarah has been an active member of INCOSE. Under her leadership as chair of the Communications Committee during 1994-95, ***INSIGHT*** and the INCOSE web site became realities, and the first membership list was distributed to members. She led the search for INCOSE's new Managing Executive, including searching out, soliciting bids, and assessing responses, leading to the selection of Shirley Bishop, Inc.

Sarah has presented numerous papers at INCOSE symposia, often to standing-room-only audiences, and she has been a frequent contributor and assistant editor for ***INSIGHT.*** Currently, Sarah is on the editorial board of *Systems Engineering, The Journal of The International Council on Systems Engineering* and a member of the Metrics Working Group. Sarah has been active in the systems engineering standards and capability models field, having participated for a short time on the committee that is merging the Capability Assessment Working Group's SECAM with the SE-CMM.

Sarah has demonstrated the combination of leadership skills and technical expertise so important to her new role on the INCOSE Technical Board. On behalf of INCOSE, I would like to express my appreciation to the Software Productivity Consortium for supporting Sarah in her work for INCOSE.

Chapters Committee

Co-Chairs: Ken Kepchar, gkkep@inlink.com, Sam Rindskopf, m.sam.rindskopf@notes.ymp.gov

The Chapters Committee is the primary conduit for chapter leadership to share issues, experiences, and ideas at the international level. It provides chapter leaders the opportunity to meet face to face and discuss what does and doesn't work when it comes to maintaining and growing an active chapter. Because of an overlap of interest items, our meetings are conducted jointly with the Membership Committee.

We had especially strong representation from the European chapters. John Mead, representing our U.K. Chapter, briefed their plans for INCOSE '99 in Brighton, England, and requested the aid of the other chapters in advertising the symposium.

D. Alex Chuang (Colorado, Front Range Chapter) shared their approach to a chapter strategic plan. The information presented has been distributed to all chapters over the chapter reflector via the minutes of the committee meeting.

Several directors attended to solicit the views of the chapters. As has become tradition in recent years, Bill Schoening (INCOSE President) spent time with the committee addressing issues that the members raised. Bill discussed INCOSE's effort to upgrade the web site, plans for the Journal, and status of symposia between now and 2001. Questions focused around communications, INCOSE products available to the chapters, and enhancing member value. Bill felt that the chapters could best support INCOSE's aims through continual contact with each of our members. I would add to that thought with an observation. Our most successful and robust chapters are those in which the members have taken active roles in making things happen, rather than relying strictly on chapter leadership to provide momentum and creative energy. In other words, your chapter leadership is typically dedicated, enthusiastic, and investing a good deal of themselves to make the chapter and INCOSE a success. Please consider investing a little of yourself to add to the chemistry.

Regional conferences around the world were discussed. There is a Region III event this December in conjunction with the European Software Institute. Dona Lee (Washington Metro) discussed plans for a Region V conference early next year, and John Clouet (Region II director) provided a status of efforts to sponsor a conference in 1999. The Region II Conference is being planned for August of 1999, probably in Las Vegas. The conference is being organized in conjunction with several universities that have collaborated in the past to host an International Conference on Systems Engineering. The universities are the University of Nevada, Las Vegas; the University of Wroclaw, Warsaw, Poland; and Coventry University, U.K.

The Chapters Committee is also

charged with encouraging the development of new chapters. The official INCOSE family grew by two when Bill Schoening announced the official chartering of the Central Virgina chapter, headed by David McConnell, and the Hampton Roads Area chapter, with Albert Motley as its first president. We want to extend a warm welcome to both chapters.

The interest level in starting new chapters was extremely high this year. A workshop on the process to form and charter an INCOSE chapter was well attended by symposium participants from all regions within North America, and from such geographically diverse countries as Taiwan, Norway, and Israel. Also on hand to answer questions were a number of INCOSE members who were instrumental in starting chapters in the past. The New Chapter startup kit was distributed to all interested attendees, and will be made available shortly on the INCOSE Web site for downloading. If the enthusiasm demonstrated at the meeting is any indication, we should have the pleasure of announcing several more chapters at the International Workshop in January.

If there are topics your chapter wishes to discuss at the International Workshop, or you have any questions, please contact either of us by email or phone: Ken (314-234-8156) or Sam (702-295-3943).

Status Report From Your Technical Board Chair

Donna Rhodes,Technical Board Chair,
donna.rhodes@lmco.com

The INCOSE Technical Community's vision is to be ***recognized internationally as the center of competence for investigation, development, and dissemination of world class systems engineering processes, practices, standards, and information.*** We have continued to make excellent progress toward realizing the vision in each of six key areas, as follows.

(1) Develop and disseminate high quality technical products and services. In 1997, we released two products: INCOSE SE Capability Assessment Model and Questionnaire and the INCOSE Metrics Guidebook. During the first part of 1998, we have released four more products:

1. MIST (led by NSWC/DD), an electronic metrics catalog (available from NSWC/DD; contact: Bill Farr);
2. SE Measurement Primer, an introduction to measurement practices and principles (downloadable from the web site; contact: Garry Roedler);
3. SE Process Handbook (developed by the San Francisco Bay Area chapter), a comprehensive sourcebook of systems engineering (may be ordered from Central Office); and
4. SE Brochure (joint with AIAA), describing basics and benefits of systems engineering (on the web site, or contact: Rich Harwell, SE Management Technical Committee Chair).

Many other products are nearing completion. The Concepts and Terms Working Group has released a draft of the Glossary of Terms & Concepts (available for member review on the web site). The SE Applications Technical Committee released Version 2 of the SE Application Profiles for member review. Following review and update, these documents will enter the Technical Board approval cycle for release as INCOSE Technical Products. INCOSE voted to approve the EIA 632 Standard (INCOSE was a joint developer with EIA) and the EIA/IS 731 SE Capability Model (joint with EIA/EPIC); the release of these standards is anticipated shortly. Watch the web page for details of availability.

Many other products are in development; some examples are:

- The Measurement Working Group is collaborating on a Practical Systems Measurement initiative, to result in a systems/software guidebook (contact: Garry Roedler).
- The Systems Architecture Working Group is developing a Systems Architecture Primer, and participating in the IEEE P1471 architecture standard effort (contact: Mark Maier).
- The Requirements Working Group continues to work on an executable Requirements Management Model (contact: David Jones).

(2) Promote effective interchange of ideas, practices, and lessons learned. This second element of the vision is addressed by a number of activities. ***INSIGHT*** editor, Valerie Gundrum, has been active in recruiting theme editors, with upcoming issues now focusing on key technical themes. Regions and chapters are holding informative events. The Vancouver symposium included very robust tutorials, technical sessions and panels. Many of our interest groups and working groups are working on lessons learned and case studies. Several new groups are being formed including a Commercial Aircraft Interest Group (Joe Simpson) and a Railroad Transportation Interest Group (John Williams), both within the SE Applications TC.

(3) Collaborate with sister organizations on global initiatives. Our collaboration with other organizations is increasing, resulting in very good progress on key initiatives. Some of these include collaboration with: AIAA on the SE Brochure; EIA on EIA 632; EIA and EPIC on EIA/IS 731; IEEE on Architecture Standard P1471; ISO on the 15288 Standard; Joint Logistics Commanders Joint Group on SE on Practical Systems Measurement and Reengineering guidebooks; NDIA on various efforts and conference participation; NSWC/DD on the MIST project; and SEDRES on Tool Interoperability Standards. Under formation are collaborations with Project Management Institute (PMI), SAE, and the Human Factors Engineering Society (HFES).

(4) Advance state of practice through process, technology, and knowledge transfer. Over a dozen informational papers and reports were released in 1997. Many more have been released in 1998, with others in progress. Many of these are or will be available on the web page. Refer to the INCOSE Technical Products & Services Plan (on the web) for a full listing.

Technology Policy and Other Science and Engineering Fellowship Programs in Washington, DC

The American Association for the Advancement of Science invites applications for one-year public policy fellowships, which bring scientists and engineers to Washington, DC, to work in the:

U.S. Congress
U.S. Department of Defense
U.S. Department of State
U.S. Agency for International Development
RAND Critical Technologies Institute
U.S. Department of Agriculture
U.S. Environmental Protection Agency
U.S. Food and Drug Administration

Applicants must be U.S. citizens and must have a Ph.D. or equivalent doctoral level degree at the time of application (January 1999) from any physical, biological, or social science or any field of engineering. Persons with a master's degree in engineering and at least three years of post-degree professional experience may also apply. Federal employees are not eligible for the fellowships.

The programs are designed to provide each Fellow with a unique public policy learning experience and to bring technical backgrounds and external perspectives to decision making in the U.S. government. Stipends vary by program. All applications must be postmarked by January 15, 1999. For further information and application instructions call 202/326-6700, fax 202/289-4950, or e-mail science_policy@aaas.org

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Faculty Position in Systems Engineering University of Idaho at Idaho Falls

The University of Idaho has identified Systems Engineering as an area of strategic priority, which will receive special attention in terms of resource allocation and faculty renewal. Systems Engineering is responsible for the big picture in the development and operation of complex systems. It must ensure that the system satisfies its requirements throughout the entire system life cycle; from cradle to grave. The University of Idaho has recently created a Master of Engineering in Systems Engineering degree and is seeking qualified faculty in Idaho Falls to help implement and build the program. The new faculty member would be expected to coordinate this Masters degree program as well as establish an independent research program in Systems Engineering. Qualified candidates should have a strong commitment to research and teaching. Qualified candidates should have a Ph.D. or equivalent degree in Systems Engineering or related field or a Masters degree and at least ten years of industrial experience as a systems engineer. This tenure track position may be at the assistant, associate, or full professor level.

The appointment could be for twelve months, or for nine months with a three-month contract for summer research and development activities with Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho Falls. INEEL will also entertain research proposals in the area of systems engineering. Further information on the University of Idaho is available at http://www.uidaho.edu and information about INEEL is available at http://inel.gov.

Applications with a curriculum vitae and names and phone numbers of three references should be sent to David M. Woodall, College of Engineering, University of Idaho, Moscow, Idaho 83844-1011; phone number: (208) 885-6479; e-mail: woodall@uidaho.edu. The screening of candidates will begin on October 12, 1998 and will continue until the position is filled. The University of Idaho is an equal opportunity employer. Women and minorities are encouraged to apply.

The Tools Database Working Group (TDWG) has updated the tools survey information on web, and the Measurement Working Group is collaborating with the TDWG on a measurement tools survey. As you know, we have begun publication of our quarterly INCOSE *Systems Engineering* Journal, and members are highly encouraged to contribute to the publication. Working groups established under Education & Research TC are creating resource lists of education and training.

(5) Advance state of art through research and development initiatives. The Education & Research Technical Committee, led by Chair Dennis Buede and Co-Chair Phil Brown, with leadership assistance from Past President Eric Honour, has been focused on establishing the SE Center of Excellence. A research agenda has been created, and the Technical Board will serve as an advisory board to work to prioritize research priorities. The SECOE has completed two proposals for research projects, with others underway. Refer to the SECOE web page for more details (www.secoe.org). Some efforts of this committee will be highlighted in the Spring issue of ***INSIGHT***.

(6) Create the infrastructure for realizing this vision. The infrastructure for realizing our vision includes people, processes, and tools. INCOSE's Technical Community is comprised of seven Technical Committees (TCs), comprised of over 25 Working Groups (WGs) and Interest Groups (IGs), under the oversight of the Technical Board (TB). The INCOSE Technical Board is the strategic planning and advisory body of the organization. Chairing this board has been a rewarding and challenging experience, and in 1998 two co-chairs have joined me: Heinz Stoewer and John Snoderly. John Snoderly will take over the role of Chair in January of '99.

Terry Robar continues as Technical Board Assistant, and Stuart Arnold as an International Representative. The officers lead meetings, resolve issues, and interface with the Board of Directors, Corporate Advisory Board, and Symposium Committee, as well as with other INCOSE committees and external organizations. The members of the Technical Board include the officers of the Technical Committees and additional special assignment representatives. Our INCOSE technical leadership has grown in strength and numbers. We have increased the international diversity of our leadership by adding many non-U.S. leaders to the existing leadership. This greatly enriches our technical efforts.

The technical leadership information can be accessed on the web page, which includes the following changes and additions:

- Sarah Sheard replaces Rich Widmann as Chair of the SE Measurement Technical Committee. John Worl continues as co-chair. An additional co-chair (non-U.S.) will be added in the future.
- Rich Widmann remains on the Technical Board in a special assignment to develop the skills taxonomy, a high-priority task.
- Jerry Fisher and Ken Jackson have been appointed Co-Chairs of the Processes and Methods Technical Committee, chaired by Dick Wray.
- James Martin was appointed to head up a new Standards Technical Committee, and has been joined by two co-chairs, Ralf Hartmann and John Velman. The TC will serve as a focal point for coordination of INCOSE participation in standards efforts and in educating members about standards.
- International co-chairs are being identified to join the Modeling & Tools Technical Committee (Mark Sampson, Chair); the Education & Research Technical Committee (Dennis Buede, Chair; Phil Brown, Co-Chair), the SE Management Technical Committee (Rich Harwell, Chair; Elaine Hall, Co-Chair); and the SE Applications Technical Committee (Bill Mackey, Chair; Scott Jackson, Co-Chair).

The processes by which we operate are being formalized, and include many policies and the Technical Community Procedures (on the web). The web is becoming our most important tool, and the Communications Committee is hard at work at setting up a new server and services for web maintenance. If you are not already involved in a working or interest group, I encourage you to do so. I am certain you will find the rewards outweigh the effort expended.

Promote INCOSE!

To obtain materials to promote INCOSE in the workplace and at events such as regional conferences, symposia, and National Engineer's Week, contact the INCOSE Central Office at –

incose@ halcyon. com,
800-366-1164 (toll-free U.S.),
(206) 361-6607, or access the
INCOSE WWW page at–
http:// www.incose.org.

- Please note our new address:

2150 N. 107th St., Suite 205
Seattle, WA 98133-9009

We supply INCOSE brochures, display table signage, and informational materials.

INCOSE Online

E-Mail Reflectors

Randy Case, Co-Chair Communication Committee,
rcase@gar.esys.com

There are two main e-mail lists (or reflectors) that are for INCOSE member use. These lists are ***NOT*** for job postings, tool sales, or workshops (unless these are INCOSE sponsored).

The discussion list is a forum for discussion of questions, issues, lessons learned, best practices, research topics, and sources of additional information on systems engineering. For INCOSE members to subscribe, send e-mail to:

incose-discuss-request@xor.com

with the following command in the body of your e-mail:

subscribe incose-discuss your_e-mail_address

If, for some reason, you wish to be removed from the discussion list, send e-mail to:

incose-discuss-request@xor.com

with the following command in the body of your e-mail:

unsubscribe incose-discuss your_e-mail_address

To post a message, send e-mail to:

incose-discuss@xor.com

The administrative list is devoted to announcements of INCOSE and systems engineering related meetings, workshops, publications, and communication of INCOSE business to the membership. It is a moderated list. To subscribe, send e-mail to:

incose-admin-request@xor.com

with the following command in the body of your e-mail:

subscribe incose-admin your_e-mail_address

If, for some reason, you wish to be removed from the list, send e-mail to:

incose-admin-request@xor.com

with the following command in the body of your e-mail:

unsubscribe incose-admin your_e-mail_address

To post a message, send e-mail to:

incose-admin@xor.com

Web News

Valerie Gundrum, Communications Committee,
valerie.gundrum@lmco.com

The INCOSE world wide web presence has been improved many ways. In the last issue of ***INSIGHT,*** we did not include any information on the website, because many changes were underway. While many of these changes will be invisible in your everyday access of the INCOSE web page, we wanted to let you know what's been done, and recognize the efforts of the people who have made the "behind the scenes" things happen.

■ **Web Site Updated.** To most members, the most visible improvement is that the website has been completed updated. Many new, pertinent information and links have been included, such as:

- SE Center of Excellence
- Brighton '99 Symposium website
- Metrics Primer
- SE98 Symposium in Australia website
- Abstracts from the 1998 Symposium
- Membership data base
- Officer and leadership contact information
- Links to several chapter-sponsored web sites
- Updated the Yellow Pages and other related links of interest
- INCOSE work product ordering information
- Much more!

You are encouraged to browse the web site and provide additional suggestions.

■ **New Webmaster.** To facilitate timely entry and update of materials on the website, the organization made the decision to hire a professional webmaster. INCOSE will no longer rely on volunteers to maintain the website. The Communications Committee received the go-ahead to seek and hire a webmaster during the Vancouver symposium. The reason for this decision was the conflicting time constraints experienced by our already overworked members. Thank you to the members who stepped forward and offered leads and candidates. As of September 1, James Haffey will be responsible for maintaining www.incose.org. You can send recommendations and changes to Jamie by clicking on "webmaster" at the bottom of any web page.

■ **New Server.** The last major upgrade to INCOSE's web presence is a new server. Thanks to the generous donation of Compaq and the diligent efforts of Mesa Systems, the organization has received a DEC server. This will reduce the costs associated with renting server space and maintaining the discuss-list and admin-list reflectors. The new server was brought "online" in early September. Many thanks to Cassandra Fleetwood of Medtronic in Phoenix, Arizona, for her efforts in getting our new server online.

■ **Up and Coming.** With the addition of the new server, there are some additional services that INCOSE will soon offer its members. In the future, we would like to offer INCOSE email addresses for members. Your email address will bring attention to the fact that you are proud to be a member of INCOSE (for example, gundrum@incose.org).

Another benefit of importance to committees and working groups will be the availability of Mesa Vista, a product of Mesa Systems Guild, Inc. This product allows several people to work in a web-based, collaborative environment that facilitates work product development across diverse geographic locations. If committee and working group chairs would like more information about this product, please visit the Mesa Systems website (www.mesasys.com).

Any comments or issues in regard to INCOSE Online can be addressed to the chairs of the Communications Committee, Randy Case (rcase@gar.esys.com) or Valerie Gundrum (valerie.gundrum@lmco.com).

The SESA-Forum List

Andrew Gabb, agabb@tpgi.com.au

The Systems Engineering Society of Australia (SESA) operates an email mailing list which may be of interest to INCOSE members. Although the list is closed, INCOSE members are eligible to subscribe as a result of the affiliation between INCOSE and SESA. The SESA-Forum list is closed but not moderated. This means that only SESA (and INCOSE) members can subscribe to the list, but once you are on the list you can post to it, as can the other subscribers. SESA thanks Adacel for providing the resources to run this list.

■ **Posting to the List.** To post to the list, send your posting to: sesa-forum@adacel.com.au

For your posting to be accepted, you MUST post with the email address that you used to subscribe. Note that for many of us, the email address we give to others is not exactly the one that goes out with our mail. You can test this by sending some mail to yourself. If you use a different address to post, you may get a "bounce" messsage, but it will only go to the owner of the list (who will normally do nothing). This is a cheap way to annoy the list owner (!).

■ **Replying to the Sender.** To reply only to the sender of a posting, simply use your normal REPLY key, and your reply will not go to the list. Note that this may vary with different mail systems.

■ **Posting a Reply to the List.** If you want to post a reply TO THE LIST, you will normally need to specifically add the list address, sesa-forum@adacel.com.au, as one of the addressees (e.g., To: or CC:). You will normally find it easier to create a nickname or alias to the above address in your mailer.

You may find using the option "Reply to Sender and All Recipients" (or similar) will result in a reply to the list. Please check the addressees before you hit the Send button, though.

Note that this is a mailing list, not a newsgroup. For a mailing list, it is not appropriate to copy a reply both to the list and to the person you are replying to. All this guarantees is that they will get two copies!

■ **Subscribing.** To subscribe to the list, send the following message in the body of your message (the Subject line is ignored):

subscribe sesa-forum
or
subscribe sesa-forum youremailaddress
to
sesa-forum-request@adacel.com.au.

Your request will go to the list owner, and you may have to wait a while before it is approved. Please be patient.

■ **Unsubscribing.** To unsubscribe from the list, send the following message *in the body of your message* (the Subject line is ignored):

unsubscribe sesa-forum
or
unsubscribe sesa-forum youremailaddress
to
sesa-forum-request@adacel.com.au

If you have problems, contact Andrew Gabb, List Owner, agabb@tpgi.com.au.

Thanks for your help!

Through the generous support of two organizations and their employees, INCOSE received a new server for hosting our website. We greatly appreciate the generosity of these people and their companies.

Mike Bousquet, Mesa Systems Guild, Inc., was instrumental in locating a server and facilitating the transition to the organization.

Jeff Cormier, Compaq Computer Incorporated, was the principal person involved in the donation of the DEC server located within his company. In addition, we would like to acknowledge Jeff's manager, **Peter Warren**, for his support.

A PICTURE IS WORTH A THOUSAND HOURS.

The path to a successful embedded system is often blocked by that age-old obstacle– the rush to implementation without adequate time to analyze design alternatives and verify your system's behavior. *Sound familiar?*

But what if there were a way to "freeze the clock," giving you more time to analyze and validate, and **prove** that your design behaves correctly before it's even implemented?

And what if you could automatically generate code for a virtual prototype of your system right at your desktop? Or for a physical prototype that runs on real-time operating systems like Wlnd River's VxWorks™?

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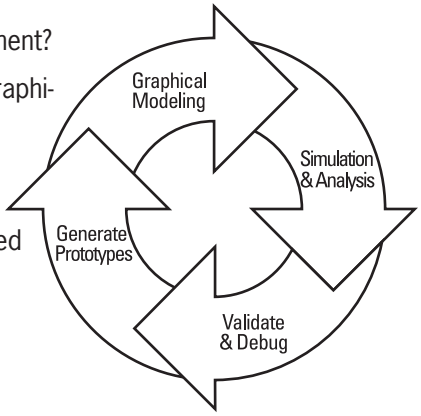

Statemate Magnum graphically specifies, models, analyzes and prototypes a system's behavior in the early phases of design.

Statemate MAGNUM will remarkably change your embedded systems development paradigm from time spent coding to time spent designing.

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Industry News

The Development of an ISO Data Exchange Standard for Systems Engineering

Julian Johnson and Sylvain Barbeau, ESPRIT Project 20496 "SEDRES," julian.johnson@bae.co.uk, sylvain.barbeau@espace.aerospatiale.fr

This article describes the background, the current status, and the future work within the framework of the International Standards Organisation for the development of a data exchange standard covering the systems engineering domain.

Integrated product development frequently involves multi-company and multi-national teams, using heterogeneous design tool sets. Systems engineering (SE) must be able to operate in this environment. A number of years ago the major European aerospace companies, realizing the need for a design data exchange standard that would facilitate the systems engineering process against this background, initiated the research project SEDRES. This project is producing a neutral data exchange standard based on STEP (ISO-10303), that will embrace product definition aspects crucial to successful SE: product requirements, systems architectures, product functionality, allocation, traceability and configuration management information. The standard will enable SE tools to exchange such information, and should be applicable to many industries.

SEDRES is a three-year European Commission-funded ESPRIT project, running 1996-1998, which was initiated by Aerospatiale, Alenia, British Aerospace, DASA, and Saab. Also contributing are the Universities of Loughborough, Linkoping, and the Australian Centre for Test & Evaluation.

Although the intention of SEDRES is that it produces, in an incremental way, a potential draft standard for SE data exchange, a key facet of the project is that it proposes an activity within the ISO forum, in the form of an STEP Application Protocol (AP) development track, and makes available its draft standards to this activity as a potential starting point. It is the ISO working group activity that will formally develop the International Standard.

STEP has been identified by SEDRES as the most appropriate standards technology to adopt for a number of reasons. STEP provides a set of facilities that allow for easy extension by:

- providing a structure based on APs for the description of new domains;
- providing a set of Integrated Resources (IRs) that give potentially re-usable building blocks; and
- providing a set of Application Interpreted Constructs (AICs) to ease AP-interoperability.

STEP has aspirations to achieve data exchange for all aspects of product definition, and many elements of STEP are now mature and in production use, particularly in the product geometry and manufacturing areas. Moreover, the techniques used in STEP ease formalization of the domain included in any new AP. This situation has led to a New Work Item proposal within area TC184/SC4 in order to include the system engineering domain in the STEP standard.

To date, several actions have been undertaken toward the STEP community in conjunction with national standard bodies and STEP centers, including:

- proposed a New Work Item (NWI) on system engineering data exchanges at the ISOTC184/SC4 in October 1996; and
- submitted a document featuring the first draft ("Capability/1") data model from the project to the ISO community to get the NWI from Phase 0 to Phase 1 in May 1997 via various national standard bodies.

Phase 1 within the ISO approach represents the real start of the activity on the system engineering standard since the main goal of that phase is to produce a committee draft document which contains the technical material for the application protocol being developed. The vote for the migration to Phase 1 at the ISO took place from August to December 1997. The proposal has been accepted by the following countries (countries with an asterisk have planned to commit resources to the project):

Australia	Norway
Hungary*	France*
Netherlands*	Korea, Republic of
Romania	Japan
Switzerland	Sweden
United States*	United Kingdom*

Since Phase 1 has been accepted, the system engineering working group can now convene to start the development of the committee draft (CD) for the ISO for what is now called as AP233 "System Engineering." It is anticipated that the work performed in SEDRES can be used as a basis that can be enhanced according to the contributions of the working group participants. Moreover, it appears that the system engineering application protocol has some interactions with other existing APs such as AP208 and AP214 (Life cycle management–Life process/Core data for automotive mechanical design processes). The first meeting on system engineering within TC184/SC4 took place in Bad Aibling (8-12 June 1998). Then, a set of meetings are planned for each ISO TC184/SC4 plenary session, and a set of special purpose meetings can be organized in order to push the technical work towards achieving a CD within the schedule given by the ISO. The working group plans to have the Final Draft International Standard (FDIS) ready three years after the CD work starts (see Fig. 1 on next page).

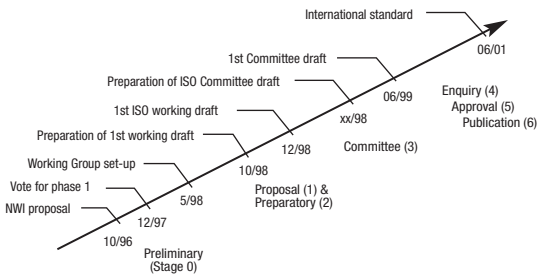

Figure 1: AP233 Development Schedule

The development of such a standard dedicated to system engineering will enhance the system engineering process within companies, since it gives the opportunity to interconnect system level design tools and specialist discipline design tools (for instance, CAD/CAM tools and software engineering tools). This link between the different levels of design is also one major reason for choosing STEP within the system engineering domain, since it allows for consistency in exchanges throughout the product life cycle (from early requirement elicitation to production). This consistency applies both to the technology used (in this case, STEP) and to the product data management approach supported in STEP, with the recent progress in the international agreement on the STEP Product Data Management (PDM) schema.

Finally, although the start of the ISO AP233 working group is a significant step forward in realizing the vision of neutral data exchange, interested parties need to ensure that they participate in this work, via their appropriate national representative. Within Europe, the SEDRES team is already exploring a follow-on project that can maintain the momentum of active prototyping and evaluation work for the duration of the ISO activity, and is keen that the rest of the international systems engineering community also considers complementary coordinated activity. Clearly, INCOSE can play a significant role in fostering such work, by its members liaising with their national representatives on the working group.

Seattle Chapter Meets with Masaaki Imai

John Worl, worl@tdtech.com

During the past 15 years, the United States has undergone a transformation in business and manufacturing processes that has resulted in the re-emergence of many U.S.-made products that qualify as truly "world class." While we can all name a number of failures and discuss how some half-baked ideas made it into the workplace, there are some stand-out names that have led this quality revolution. Industries, in most countries of the world, are now practicing the basic principles of the leading gurus of quality. Who are the standouts? My short list would include: Deming, Juran, Taguchi and Imai.

On July 16, about 20 members of the Seattle Metro Chapter had the special opportunity to spend several hours with Masaaki Imai, the father of Kaizen. As many of you are aware, Kaizen is a set of practical concepts for continual improvement. More recently, Mr. Imai has outlined a set of concepts and practices that might be considered a "Kaizen to Kaizen." This newer conceptual framework is what he discussed with the Seattle Metro Chapter.

Gemba Kaizen is the title of his latest book and the focus for his current practice in helping businesses improve. Gemba means "real place," referring to where the real work is being done. There is more than one Gemba in each company and these Gemba will vary from business to business. Mr. Imai suggests that in a typical business there are three basic areas for Gemba, "Design, Make and Sell—these are the Gemba Guys." All other activities are supporting functions. And, as with Dr. Deming, Mr. Imai is quick to place the success or failure in these three areas on the doorstep of management.

As before, Imai concentrates on low-cost approaches to improvement, those activities that will produce positive results while minimizing

continued on page 42

DoD Value Engineering Achievement Awards for 1998 Presented

The 1998 Department of Defense Value Engineering Achievement Awards were presented on June 17, 1998 during a ceremony held at the Pentagon. DoD's Director of Test, Systems Engineering and Evaluation, Patricia A. Sanders, made the presentations.

Value engineering is a systematic functional analysis leading to actions or recommendations to improve the value of systems, equipment, facilities, services, and supplies. The objectives are to improve quality and to reduce cost. The awards are intended to recognize significant achievements in value engineering during the past fiscal year and to further the use of value engineering by DoD personnel and its contractors.

During the last fiscal year, 4,168 in-house value engineering proposals were accepted with reported savings of $661 million. Another 221 contractor-initiated value engineering change proposals were accepted with additional savings of $45 million.

The value engineering award program is a highly visible acknowledgment of exemplary achievements and encourages additional projects to improve in-house and contractor productivity. An award winner from each DoD component was eligible for selection in the following seven categories: (1) program management, (2) individual/team, (3) procurement/contract administration, (4) value engineering professional, (5) field command, (6) installation, and (7) contractor. Additional "special" awards were given to recognize innovative applications or approaches that expanded the traditional scope of value engineering use.

The 1998 Value Engineering Achievement Awardees are:

■ **Army**
- Program Management: Multiple Launch Rocket System
- Project Office Individual/Team: Rosemary Lomba and Carole Winterhalter; U.S. Army Soldier Systems
- Command Professional: John Vogel, U.S. Army Engineer District, Baltimore
- Procurement/Contract Administration: Sheri Patton, Bryce Atkinson, Tommy Snurr, and Julie Stammen, Defense Contract Management Command General Dynamics, Lima
- Field Command: U.S. Army Soldier Systems Command
- Installation: Anniston Army Depot
- Contractor: Hughes Aircraft Co.
- Special: Timothy Karcher; U.S. Army Industrial Operations Command

■ **Navy**
- Program Management: Advanced Amphibious Assault Vehicle Auxiliary, Suspension, Automotive Drive Train
- Integrated Product Teams Individual/Team: Combat Systems Consolidation Business Strategy for AEGIS Ships Team
- Procurement/Contract Administration: Resident Officer in Charge of Construction, Bancroft Hall
- Installation: Naval Aviation Depot, Cherry Point
- Contractor: Rogers, Lovelock and Fritz, Inc.
- Special: New Attack Submarine Non-Propulsion Electronics System Integrated Product Team
- Special: William McAninch, Office of the Assistant Secretary of the Navy (Research, Development & Acquisition); Henry Ball, Boeing Defense and Space Group; and Joseph Lambert, SAVE International

■ **Air Force**
- Program Management: NAVSTAR Global Positioning System Avionics Integrated Product Team
- Individual/Team: Henry Duhamel, Electronic Systems Center
- Procurement/Contract Administration: Lee Anderson and Martin Kradlak, Air-to-Air Joint Systems Program Office

■ **Defense Logistics Agency**
- Program Management: Compact Disc Recordable Project Team, Defense Supply Center Columbus
- Individual/Team: Maryrose Burns, Defense Personnel Support Center
- Professional: Joshua Perry, Defense Supply Center Richmond
- Procurement/Contract Administration: Annette Jiles, Defense Contract Management Command - Detroit
- Field Command: Defense Industrial Supply Center
- Contractor: Jack Young Associates, Inc.
- Special: Hand Emplaced Minefield Marking System Project Team, Defense Supply Center, Richmond

■ **Ballistic Missile Defense Organization**
- Program Management: PATRIOT/PAC-3 Project Management Office
- Individual/Team: Joel Ellis, Theater High Altitude Area Defense Project Management Office
- Professional: Nancy Sims, U.S. Army Aviation and Missile Command

■ **Defense Finance & Accounting Service**
- Individual/Team: Human Resources Directorate

■ **National Security Agency**
- Individual/Team: James Cornett, National Security Agency and Brett Salkeld, Betz Dearborn Water Management Group

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Status of EIA 632

James N. Martin, j-martin@ti.com

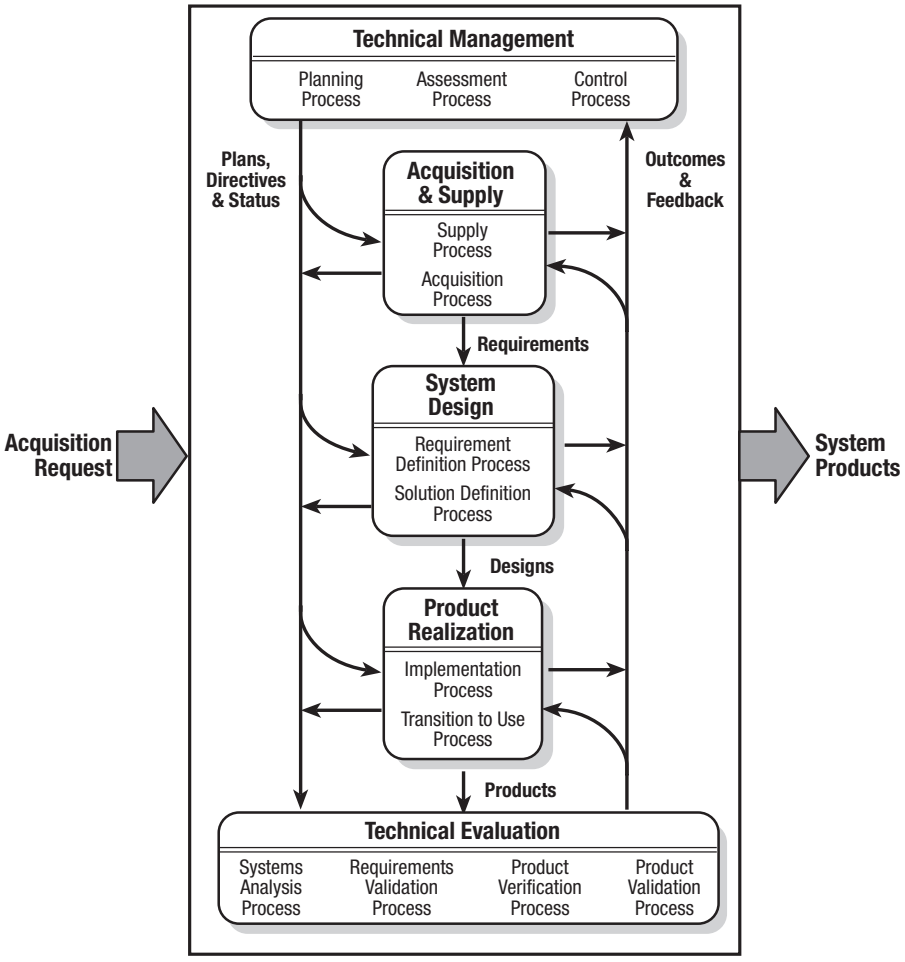
The standards proposal ballot of EIA 632 ended on July 20th. Reviewers submitted over 200 comments. This ballot passed with a unanimous affirmative vote. Full release is planned for November 1998. Copies of this document can be purchased from Global Engineering Documents: <http://global.ihs.com/.>

EIA 632 is the U.S. national standard intended for specifying the "processes for engineering a system." It contains 13 processes and 33 requirements associated with these processes. It also contains representative tasks for each process and expected outcomes for each of these tasks. Further information on the EIA 632 standardization activity can be found at: <http://www.eia.org/gd/gdeoc/g47/eia632-nf.htm.>

This standard was developed jointly with participation from INCOSE and the EIA G47 Systems Engineering Committee. Information on the G47 Committee activities can be found at: <http://www.eia.org/gd/gdeoc/G47/eiag47.htm.>

It is expected that "second tier" standards will be developed for different technology and business domains using EIA 632 as a generic framework. Also, system developers will use EIA 632 as a basis for developing their internal policies and procedures with respect to their product development activities.

INCOSE working groups can use this standard as a common framework for developing working group products. It is expected that this standard will help standardize some of the terminology used in the practice of systems engineering.



Masaaki Imai *continued from page 40*

radical change. He had a few polite comments regarding his ideas about the needs for "reengineering" and the results of applying this approach too often. Even waiting until "reengineering" is necessary raises a significant number of questions to one who recognizes the advantages of long-term incremental improvements. His statements did not bring into question the need for such actions, however. Elimination of waste (time, material, etc.), Good Housekeeping (the 5S's), and Standardization are the foundations of Gemba Kaizen. Mr. Imai used several examples of where these principles have been applied with astounding success. During his presentation, Mr. Imai postulated several thought provoking ideas such as measuring inventory by time, as opposed to more conventional methods, as you look to eliminate waste within your processes.

As a parting thought, Mr. Imai suggests there is a "hidden agenda" in Kaizen, namely:

a) learning together—not as a teacher/student,
b) be physically engaged in the process,
c) it is all common sense, and
d) the manager's role is to challenge.

Imai's book is reviewed on page 43, and a description of some of the principles are provided in more detail.

Wanted! Host for 1999 International Workshop

Richard Schwadron, rschwadron@mdc.com,
Ginny Lentz, lentzva@utrc.utc.com

Is your INCOSE Chapter interested in hosting the January 2000 INCOSE International Workshop? If yes, please contact Ginny Lentz or Richard Schwadron by mid October. They will provide guidelines on preparing a proposal presentation for review and selection during the January 1999 INCOSE International Workshop.

The Information ByWay

CORONA, Spy in the Sky

Jack Fisher, Seajnf@aol.com

One of the most fascinating stories to come out of the post-Cold-War information declassification is that of the CORONA spy satellites. Two books have recently been published which chronicle the history of the CORONA, a highly classified photographic reconnaissance satellite. These two books are referenced at the end of this article.

The CORONA satellite system consisted of the satellite, launch system, and the recovery system. The satellites were launched from Vandenberg Air Force Base located on the coast of southern California, about 140 miles west of Los Angeles. The launch vehicle was the Thor-Agena. The first stage was the already-proven Thor Intermediate Range Ballistic Missile developed by Douglas Aircraft. The Agena, developed by Lockheed Aircraft, served as a second stage to the Thor, as well as a satellite bus. A typical payload included a camera and a film canister. The film, once exposed, was returned to earth in a reentry capsule, designed and built by General Electric, separated by a ground command that was transmitted from the Kodiak tracking station in Alaska. In the time period from 1959 to 1972, a total of 145 of these satellites were launched. The 866,000 frames of film returned provided coverage of a total area of 610 million square nautical miles, some 90 times greater than the total land area of the Soviet Union.

After separation, the capsule was spun up and decelerated to reentry speed with a solid rocket motor. A parachute was deployed at 60,000 feet to slow the rate of descent. The capsule was recovered in midair by an aircraft equipped with a trapeze that snagged the parachute and a winch to reel in the capsule. The Air Force 6593th Test Squadron, based at Hickam Field on Oahu, was assigned the responsibility for recovery. They were originally equipped with C-119 Flying Boxcars, later upgraded to C-130s.

If the capsule landed in the water a strobe light and radio beacon was activated. The capsule floated for one to three days until a salt plug dissolved and the capsule filled with water and sank. This was intended to prevent unauthorized recovery. After recovery, the film was transported to Westover AFB for processing and to Washington, D.C. for photo interpretation and further analysis.

The payload evolved over time. Early missions carried a single camera. Later missions carried both a forward and aft camera to provide stereo coverage. The first camera, designated KH-1, had a f/5 Tessar lens with a diameter of 4.8 inches and a focal length of 24 inches. The film resolution was 100 lines per millimeter which provided a ground resolution of 30 feet. Later cameras, such as the KH-4B had a f/3.5 Petzval lens with a diameter of 4.8 inches and a focal length of 24 inches. The film resolution was improved to 160 lines per millimeter and ground resolution to 6 feet. Image size was 2.18 by 29.8 inches. A photograph taken of Moscow in 1970 clearly shows a line of people waiting in front of the Kremlin to enter Lenin's Tomb. Early missions carried up to 20 pounds of film, while later missions carried 160 pounds (32,000 feet). The lenses were designed and built by Itek, and the cameras by Fairchild.

For the later missions with two recovery capsules, the film, once exposed, was routed through the second capsule, a film cutter, and finally the first capsule. Once the take-up reel in the first capsule was full, the film was cut, the capsule separated, deorbited and recovered. The mission continued with film going into the second capsule.

Another camera, the KH-5, was used for mapping, rather than reconnaissance missions. It had a focal length of 3 inches and a ground resolution of 460 feet. Not all missions carried cameras. Other payloads included atmospheric research, radiation, radio propagation, ionospheric, and radiometry instruments. For some missions instruments were carried in addition to a camera.

Predecessors to CORONA included both the U-2 aircraft and an earlier series of balloon missions. The Genetrix balloons were conceived by the Air Force (supported by the CIA) in the early 1950s as a means of gathering reconnaissance information. The large polyethylene balloons carried a camera mounted in a gondola and were designed to fly at altitudes greater than 70,000 feet. They were launched so that prevailing winds would carry them over Soviet and Chinese landmasses. After reaching the Pacific, a timer turned on a homing beacon at a preset time. When located by an aircraft, a command separated the film capsule and deployed a parachute. The capsule would then be recovered in flight with a trapeze deployed from the rear of the aircraft or by a ship from the ocean surface. The first launches of eight balloons from Scotland, in December 1954, were all failures. These balloons drifted to Yugoslavia and North Africa, but didn't go any further.

Further tests over the U. S., and crew training during 1955, led to operational readiness at the end of the year. Upon presidential approval, a total of 516 balloons were released in January and February of 1956. Launches took place from Scotland, West Germany, Norway and Turkey. A

total of 67 balloons reached the recovery area and 44 capsules were recovered. The film provided over a million square miles of photographic coverage. The balloon gondolas were ballasted to not fly above 50,000 feet, so that the about-to-begin U-2 flights at 70,000 feet would not be compromised. Soviet and Chinese air defenses, after the initial flights, managed to stop any further balloon penetrations, and the Soviet Foreign Ministry filed a protest with the U.S. No further balloons were released.

The U-2 program began with an unsolicited proposal by Lockheed's C. L. (Kelly) Johnson. Development began after presidential approval in November 1954. The project was assigned to the CIA since it was considered to be a source of strategic intelligence. The prototype U-2 made its first flight on August 1, 1955, only eight months after go ahead. The next 11 months were spent producing aircraft, resolving technical problems, and training, and operational deployment to a base near Wiesbaden, West Germany.

The first operational flights began on July 4, 1956, with a total of five flights in July. It was not anticipated that Soviet radar would be able to detect aircraft flying at 70,000 feet. It came as a surprise that these first flights were detected and interceptions were attempted. A total of 20 interception attempts were made for the first flight. MiG fighters were observed trying to zoom climb (exchanging kinetic energy for altitude), however, they could not reach the U-2s altitude as their engines flamed out. U-2 flights over the Soviet Union continued for the next four years. During this period, a total of 24 overflights were conducted. The usefulness of the U-2 was compromised with the flight of Gary Powers in May 1960.

The development of CORONA began with presidential approval in April 1958. Lockheed began development, based upon a 1-1/2 page statement of work, on April 25, 1958 and initial funding of $7 million. This was only three months after the launch of the first U.S. satellite, Explorer I, in January 1958. The first review was held May 14 and the design was frozen on July 26. The first launch was scheduled to take place in 11 months.

The classified program was directed by the CIA; however, a cover was provided by the Air Force Discoverer program. CORONA operated as a black program within the Discoverer program office. The pretext was that the capsule contained biomedical and other scientific experiments. Discoverer launches were not classified and the press was allowed to witness the launches.

The first launch countdown occurred on January 23, 1959, only 9 months after go-ahead. The vehicle was lost due to an accidental separation of the Thor and Agena prior to launch. This was not counted as failure in the project history and was designated as Discoverer 0. The first Discoverer launch, on February 28, 1959, was a test flight and did not carry a camera or a recovery capsule. Sporadic signals were received, possibly indicating that the vehicle was tumbling in orbit. However, it was later concluded that the Agena never reached orbit and reentered the atmosphere over the Antarctic.

The second launch, on April 13, included a recovery capsule with a simulated biomedical package, but not a camera. Orbit was successfully achieved, and after a full day in orbit the command to initiate the reentry sequence was transmitted from a ground station. However, the command was incorrect and the vehicle reentered the atmosphere and landed on Spitzbergen Island north of Norway. The capsule was never found although it is suspected that it was recovered by the Russians who maintained coal mines on Spitzbergen.

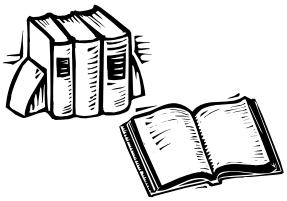
Ten further flights over the next year were all failures. Finally on August 10, 1960, three months after the loss of Gary Power's U-2, Discoverer 13 completed a successful mission. The capsule, containing diagnostic instrumentation, was recovered from the ocean. The next flight, on August 18, did carry a camera and returned the first images of the Soviet Union from orbit. This was the first capsule recovered by an aircraft.

Over the next 12 years a further 135 CORONAs were launched, a rate of almost one per month. For the first 20 launches there were only three successes, a reliability of only 15%. For the first fifty launches there were 18 successes, a reliability of 36%. For the last 95 launches there were only four failures, a reliability of 96%. A total of 161 capsules were recovered; 154 by aircraft and 7 by ship. Only two capsules were lost. Note that later missions carried two capsules that were released at different times. Typical mission duration was one day for the early single-capsule flights while for the latter missions the first capsule was separated in 2 to 11 days while the second capsule was deployed in 6 to 19 days. The vehicle could also be stored in orbit for up to 21 days before payload activation.

The strategic importance of CORONA was incalculable. As a result of the Soviet lead in launching satellites, a missile gap in the deployment of Intercontinental ballistic missiles (ICBMs) was suspected in the early 1960s. Estimates of Soviet ICBM strength varied widely. CORONA photographs in the early 1960s revealed that the Russians had at the time of the Cuban missile crisis in October of 1962, deployed only 80-85 ICBMs compared to 294 for the U.S. President Kennedy knew that we had overwhelming superiority and we could safely stand up to Khrushchev. The frustration of the Soviets was demonstrated by obscenities that were stamped out in the snow, large enough to be seen from orbit, at Tyuratam, the major launch site for Soviet ICBM development.

Other highlights in the CORONA project history include detection of Chinese preparations for their first nuclear test, verification of Israeli/Egyptian cease fire agreements after the 1967 War, detection of Soviet preparations for the invasion of Czechoslovakia in 1968, and verification of allowable missile deployments under U.S.-Soviet SALT disarmament agreements.

1. Curtis Peebles; The CORONA Project, America's First Spy Satellite. Naval Institute Press, 1997.
2. Dwayne A. Day, John M. Logsdon, Brian Latell, editors; Eye in the Sky, The Story of the CORONA Spy Satellites. Smithsonian Institution Press, 1998.



Book Reviews

Systems Engineering: Coping with Complexity

Richard Stevens, Peter Brook, Ken Jackson and Stuart Arnold, 1998, Prentice Hall Europe, British Library, ISBN 0-13-095085-8

Reviewed by Virginia (Ginny) Lentz, Past President, LentzVA@utrc.utc.com

What a read! Great cover art! Excellent simplification of complex charts!

The target audience for the book is graduate engineers trained in a specific discipline. The result of reading the book is a cogent description of systems engineering and the "essence" of the answers to questions being asked around INCOSE. I struggled with the best way to write this review–and decided to let the book write its own review by sharing quotations to demonstrate the breadth and clarity of the message.

This is a survey book–this is not, and is not meant to be, an in depth dissertation on the topic. It covers the waterfront of systems engineering. The stated objective is to be an instrument by which we might accomplish the following: "To spread the concepts more widely, systems engineering needs to present its most important concepts as simply as possible."

This is a book for any mahogany row that is considering the idea that systems engineering might be a solution to the current business objectives:

- "All parties have to work hard to make systems engineering deliver the benefits."
- "The cost of improving systems engineering processes must be justified in business terms, taking into account the cost of non quality. Potential Savings = Current cost of non quality"

These are frank discussions of the problems faced when engineering systems–the solutions and the difficulties in deciding to apply the solutions. The authors mix the art with the applied science, and identify which are which.

The authors are clear that systems engineering is not a silver bullet: "Systems engineering is a useful aid to human intelligence, but no process (or book) can ever substitute for professional judgement made with knowledge of the situation: human decisions and strategy drive the systems engineering process, not vice-versa. The development strategy has to be chosen from deep knowledge and understanding of all the issues involved. Systems engineering is the starting point for applying intelligence, not a set of rules that can be slavishly followed."

The style of the book is to address a topic, and then provide a summary and exercises for the reader. The answers to the exercises, as well as the book's illustrations, are provided on a web site (www.complexsystems.com). Readers are invited to submit recommendations for upgrading the answers.

Just a couple more quotes:

1. What is the relationship to Project Management?
   - "This book has illustrated the close link between SE and PM. The roles are overlapping and inseparable throughout all stages, and need to be closely bonded."
2. What is the relationship with systems integration?
   - "Does systems engineering have a role in this buy-it 'n' bolt-it-in quick world? Yes, in good requirements engineering. Strong user requirements specification is particularly necessary where third party products are being bought."
   - "Success in integration, verification, installation and validation is highly dependent on work that should have happened before these processes started."

I selected more than 40 quotable phrases on the first pass—this book will become a frequent reference.

Gemba Kaizen; A Commonsense, Low-Cost Approach to Management

by Masaaki Imai, McGraw-Hill, 1997, ISBN: 0070314462, $24.95 (U.S.)

Reviewed by Joseph J. Simpson

In his new book "Gemba Kaizen," best selling author Masaaki Imai expands on the Kaizen principles detailed in his previous work. The Japanese word kai, meaning change, and the word zen, meaning good, are combined to express the concept of continual improvement. Gemba is defined as the "real place" where the products are developed, produced, and serviced. In this book, Mr. Imai urges managers to focus on the activities associated with the gemba to find areas for the application of simple low-cost methods that provide greater growth and return than typical re-engineering activities.

Sophisticated technology, complex procedures, or expensive equipment are not needed to implement and benefit from the gemba kaizen approach. Three basic kaizen practices need to be incorporated into the management of the gemba. The first practice is the removal of muda, that is, waste or non value-adding activities. Eight types of muda are addressed: muda of overproduction, muda of inventory, muda of repair/ rejects, muda of motion, muda of processing, muda of waiting, muda of transport, and the muda of time. The second practice is The 5 Steps of Housekeeping. This second essential practice frequently reveals problems before they occur, because it encourages preventive maintenance and promotes self-discipline among employees. The third practice is the standardization of procedures to ensure that improvements become a regular, established part of gemba followed by everyone working there.

Building on the basic kaizen practices, the book goes on to detail the use of the "House of Gemba" concepts in conjunction with Total Quality Management, Just-In-Time, Total Productive Maintenance, and other gemba kaizen tools to achieve maximum quality in product manufacturing and customer service. This book presents an approach that will stir debate and discussion among manufacturing managers and others who are charged with developing and deploying complex technical products.

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INCOSE '99 promises to be an occasion not to be missed as we bring together practitioners of systems engineering from around the world for

Sharing the Future.

Participate in tutorials taught by world experts, briefing sessions addressing the latest developments in international standardization, a range of INCOSE's technical committees and working groups, an academic workshop and an Exhibition bringing together leading companies in the field of Systems Engineering from around the globe.

To find out more about Brighton, refer to **: www.brighton.co.uk**

For updates on plans and further details, refer to the **INCOSE '99 web site: www.incose.org.uk**

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INCOSE '99 will be different–a new continent, a fresh perspective, coverage of emerging issues.

'Brighton' your Systems Engineering in '99!

INCOSE '99 will be the same–the world's largest gathering of Systems Engineering professionals — thought-provoking, relevant papers, up-to-the-minute briefings, and a wide range of tutorials.

INCOSE '99 Takes Shape

Peter Robson, Symposium General Chair,
peter.robson@baedsl.co.uk

If you were present at this year's International Symposium in Vancouver (and what a hard act that will be to follow!), you will have heard and seen something of how the preparations for INCOSE '99 in Brighton, England are coming along. Perhaps you visited our booth in the exhibition hall as well. You may also have heard the news about our exciting first sponsorship from British Aerospace, who are generously providing the services of an independent consultant to help us with the challenge of marketing and gaining sponsorship for the first symposium to be held outside of North America.

If you weren't able to be there, we would like to share some of the emerging themes of Brighton's technical program. Because, it will be this and the wide range of tutorials that will provide you with the reason for attending (rather than the undoubted attractions of the Brighton Pavilion etc.!)

■ **The INCOSE '99 theme**: *Systems Engineering: Sharing the Future*—seeks to exploit the confluence and synergy that we are seeing between the various key issues being addressed by INCOSE world-wide. Come and share in the challenges of the breadth of applications, the diversity of techniques, and the overlap which systems engineering has with other disciplines. Respond to the powerful opportunities for development and codification of coherent generic principles.

Share the Future against a backdrop of international issues, industrial and academic alliances, alliances with other disciplines, professional bodies and between industries.

Share the Future at the close of the millennium, a future inevitably characterised by the dynamic of "sharing," where diverse interests become stakeholders in the enormous benefits to be realised when a "systems approach" is more widely and thoroughly understood by professionals.

Share the Future and be stimulated by the fruitful combination of well-established topics and emerging areas of interest that are identified in the Call of Papers. INCOSE '99 aims to deliver valuable and relevant material to systems engineering practitioners from all areas of the discipline by covering:

- Established issues in the mainstream of INCOSE activities.
- Diverse Domain Practices, lessons from which have been featured in the UK Chapter's activities since its formation.
- Relations with other disciplines and the challenge of developing synergies. Come and find out what is happening in this area; for example, in the vital relationship between project/programme management and systems engineering.
- Generic Systems Approach – Systems Engineering principles—thinking holistically—having a regard for the parts and their interactive contribution to the whole.
- Education, Research and Training, probably the greatest leverage for adding value. An academic workshop and one technical track will address this area of special interest.
- Transport and Other Emerging Sectors – The UK and Europe have seen a rapid growth of Systems Engineering applications in rail transport and transport infrastructure design. To broaden the base of interest in INCOSE membership and activities, one technical track is planned for papers on Systems Engineering practices in non-traditional sectors.
- Systems and Software Engineering – The synergy and overlap of these two established disciplines should attract considerable interest in the form of submitted papers and interested delegates.

People on the Move

Jerry Fisher has recently joined the AXYN Technology Corporation, an information technology company that specializes in Year 2000 solutions. Jerry is the Director of Operations, and his duties include the analysis, remediation, and test of embedded systems with Y2K problems. He is presently staffing the new Washington, DC office. Jerry can be reached at Fisher@axyn.com, phone (703) 403-4300.

William Fournier has moved from teaching systems engineering at DSMC to a job as a Senior Systems Engineer on the National Missile Defense program for SAIC. Contact him at wfournie@bdm.com.

Dave Thomas recently transferred from the military to the civilian world, and is working as a Research Engineer for Georgia Tech. He is located at the Arlington Research Lab in Virginia and will be working on several projects, providing Systems Engineering support to various U.S. Department of Defense offices. Dave can be reached at (703) 528-0883, or david.thomas@gtri.gatech.edu.

Jack Welsh, was recently promoted to Principal within Booz, Allen & Hamilton's Worldwide Technology Business, National Security Team. Jack's main business focus is to provide systems engineering and architectural definition to national security clients. You can reach Jack at (703) 902-6895, or welsh.jack@bah.com.

New INCOSE Publications Now Available

Several new publications are now available to add to your systems engineering library. The proceedings of the 8th Annual International Symposium, *INCOSE '98: People, Teams, and Systems* held in Vancouver, British Columbia, Canada is now available in either hard copy or CD-ROM at a cost of $60 member/$70 non-member. The Systems Engineering Measurement Primer, a product of the Measurement Working Group, provides a basic introduction to systems engineering measurement concepts and use. It can be downloaded by members at no cost from the INCOSE web site at http://www.incose.org/temp/index.html or purchased in hard copy for $20 members/$25 non-members. (Note: Contact the INCOSE Office for the password to unzip the downloaded file.)

The INCOSE Systems Engineering Handbook provides a description of the key process activities performed by systems engineers. It describes in some detail the purpose for each process activity, what needs to be done, and how it can be done. The intended audience is primarily the new systems engineer, an engineer in another discipline who needs to perform some systems engineering functions, or a more-experienced systems engineer who needs a convenient reference. It is available in hard copy for $20 members /$25 non-members. All of these products can be ordered from the INCOSE Office at incose@halcyon.com, 800-366-1164 (toll-free U.S.), or (206) 441-1164. The order form can also be downloaded from the INCOSE web site as an Adobe PDF file at http://www.incose.org/ordrform.pdf.

CrossTalk, The Journal of Defense Software Engineering

Special issue to be mailed to INCOSE members in the U.S.

In October, U.S. members of INCOSE will receive a copy of *CrossTalk*, published by the Software Technology Support Center of the U.S. Air Force. The theme for this issue of *CrossTalk* is Systems Engineering, so it is particularly relevant to INCOSE members. President Bill Schoening and *INSIGHT* Editor Valerie Gundrum encourage you to take a look. You can also view *CrossTalk* on the Web at www.stsc.hill.af.mil/Crosstalk/crostalk.html.

The STSC hopes you will subscribe to *CrossTalk* (at no charge):

- By e-mail at custserv@software.hill.af.mil
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Current subscribers do not need to reapply. INCOSE members outside the U.S. may receive *CrossTalk* by providing the U.S. address of someone who will forward the magazine to them.

Thanks go to Randall Wright for suggesting and coordinating this exchange.

new membership form

Full Page Ad
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What's Inside

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